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WAR DEPARTMENT

TECHNICAL MANUAL

THE BODY FINISHER WOODWORKER, UPHOLSTERER PAINTER, AND GLASSWORKER

MARCH 13, 1942

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THE BODY FINISHER WOODWORKER, UPHOLSTERER, PAINTER, AND GLASSWORKER

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SECTION I

GENERAL

1. General.—*a. Woodworking.*—(1) Many modern passenger automobiles have no wood in their body construction, but most Army trucks are built with wooden sills, troop seats, and bows. Considerable wood is still used also in the bodies of special-purpose vehicles produced in small numbers. Wood is often used also for seat cushion frames, both new and replacement.

(2) Although used only to a limited extent in motor vehicle body construction, wood is a basic material throughout industry, and carpentry is a fundamental mechanical trade. Section II has been designed, therefore, as a complete elementary text on woodworking, including the selection of wood and the use of hand tools as well as the more common power tools.

b. Upholstering.—In the Army as well as in commercial motor vehicle maintenance, upholstering includes repairing and replacing seat cushions and trim, as well as covers (paulins), curtains, and the like.

c. Repainting.—Repainting complete motor vehicles, or parts that have been repaired or replaced, is one of the commonest of repair and maintenance jobs. A body painter must understand the latest and most efficient repainting methods.

2. Glossary.—The following terms are defined as they are used in this manual. Become familiar with them and refer to the list whenever in doubt about a definition.

Acute (angle).—Less than 90°.

Arbor.—A shaft or spindle for holding a wheel or a cutting tool.

Bias.—A diagonal line of cut, seam, or stitching across a fabric.

Bur (rivet).—A small washer put on head of a rivet before it is peened over.

Cambium.—The tissue just inside the inner bark of a tree trunk or limb, which gives rise to the growth of new wood.

Cells (wood).—A general term for the minute units of wood structure.

Compressive.—Pertaining to pressing together, or squeezing.

Force.—The action that one body exerts upon another to change its motion or shape. Forces between bodies are always equal in amount and opposite in direction. They are usually measured in pounds.

Fungi.—Microscopic plants that feed on wood and cause stain, mold, and rot.

Grain (wood).—The direction, size, arrangement, appearance, or quality of the fibers in wood.

Gullet (saw).—The space between the tips of adjacent saw teeth.

Laminated.—Made up of layers.

Member.—Any essential part of a structure or machine.

Mortise.—A cavity cut into a piece of wood or other material to receive a tenon.

Peen.—(1) The hemispherical, round-edged, or sharp end of the head of a hammer opposite to the face.

(2) To draw, bend, or flatten by hammering with the peen.

Ply.—A thickness or layer.

Radial.—Originating from or acting upon a common center, as the spokes in a wheel.

Ratchet.—A mechanism having a toothed wheel which a reciprocating pawl (pivoted tongue or sliding bolt) engages to turn it forward, or a stationary pawl engages to hold it from turning backward.

Rays (wood).—Strips of cells extending radially within a tree and varying in height from a few cells in some species to 4 inches or more in oak. The rays serve primarily to store food and carry it horizontally in the tree. Sometimes called "medullary rays."

Sap.—All the fluids in a tree except special secretions and excretions, such as gum.

Scribe.—To scratch with a pointed instrument, such as a scriber or a pair of dividers.

Stress.—The exterior forces on a body or the interior forces resisting them. Also the interior or "locked up" forces within a body exerted by adjacent parts of the body.

Tangent.—A straight line touching any curve, and perpendicular to the radius of curvature at the point of contact.

Tenon.—A projecting portion of a member left by cutting away the material around it for insertion into a mortise to make a joint.

Tensile.—Pertaining to pulling apart.

Tufting.—A diamond or "biscuit" design produced by sewing buttons at regularly spaced points on the surface with twine that goes completely through a cushion.

Veneer.—Thin sheets of wood.

SECTION II

WOODWORKER

3. Hardwoods and softwoods.—*a.* Native trees are divided into two classes—hardwoods, which have broad leaves, and softwoods, which have evergreen leaves shaped like needles or scales. However, no definite degree of hardness divides the hardwoods and the softwoods; in fact, many hardwoods are actually softer than the average softwood. Softwoods are frequently called conifers, or coniferous woods, because virtually all the native species of softwood trees bear cones.

b. White oak, red oak, ash, hickory, and similar hardwoods are used in sills, troop seats, and bows, or the bodies of special purpose vehicles. Yellow pine and Douglas fir are largely preferred for general structural purposes. Cypress and redwood, which are particularly resistant to decay, are suitable for construction that is to be exposed to

the weather. Chestnut, which is also very durable, is used for poles and fence posts. White pine, whitewood, cherry, and mahogany are particularly satisfactory for pattern making because they can easily be worked into intricate shapes. Woods such as oak, mahogany, walnut, and maple are usually chosen for furniture and interior trim because of their attractive appearance and ability to take a high finish.

4. Structure of wood.—Figure 1 shows a cross section of a log and the nomenclature of its parts. By growth in the cambium, a tree adds a layer of wood each year, called an annual ring, on the outside of those previously formed, which increases the diameter of the trunk and pushes the bark outward.

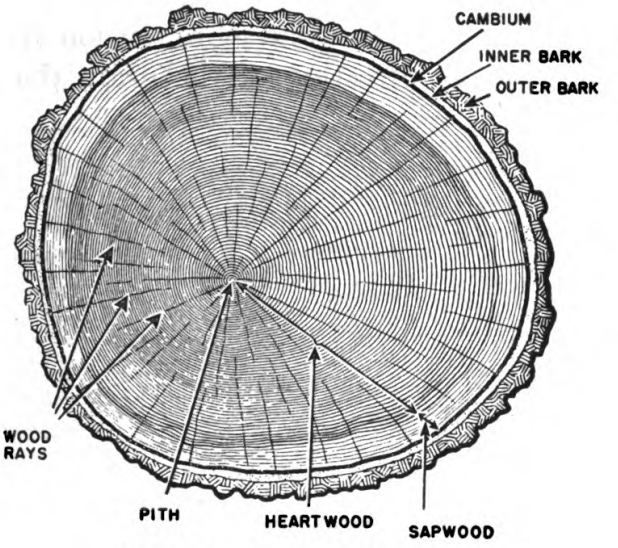

FIGURE 1.—Cross section of log.

a. Springwood and summerwood.—In many species of wood, each annual ring is divided more or less distinctly into two layers; the inner layer is springwood and the outer is summerwood. Springwood is usually lighter in weight, softer, and weaker than summerwood. In some species, such as the maples, gums, and yellow poplar, however, there is no appreciable difference in the structure and properties of the two layers.

b. Sapwood and heartwood.—The sapwood contains living cells and takes an active part in the life processes of the tree. The heartwood consists entirely of inactive tissue and serves primarily to give strength to the tree trunk. As a tree grows in diameter, the inner sapwood changes to heartwood. Usually the heartwood is stronger and more durable than the sapwood and often it can be distinguished by its darker color.

c. Wood rays.—Both hardwoods and softwoods have strips of cells, running radially to conduct sap across the grain. These are called rays, wood rays, or medullary rays. In some species of wood the rays are extremely small; in others, such as oak and sycamore, they are larger and form the conspicuous silver flake, or cross grain, that may be noticed on some sawed wood.

d. Grain.—When the annual rings are large, the grain or marking that separates adjacent rings is said to be coarse; when the rings are small, it is fine. Wood is straight-grained when the direction of the fibers is nearly parallel with the sides and edges of the board; otherwise it is crooked-grained or cross-grained. The importance of working only straight-grained wood with certain hand tools is illustrated in figure 2. A piece of lumber can stand more tension (pulling) or compression (pushing) in the direction of the grain than in any other direction.

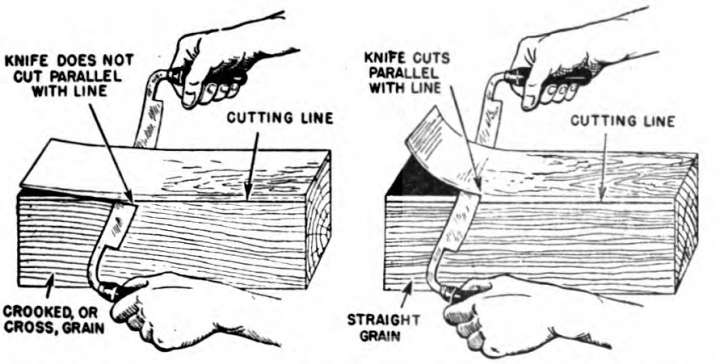

FIGURE 2.—Working crooked- and straight-grained wood with sharp-edged tool.

e. Defects.—A defect is an irregularity in wood that may lower its strength. These are the most common:

(1) *Blemish.*—Anything, not necessarily a structural defect, marring the appearance of wood.

(2) *Check.*—A lengthwise crack in the wood, which usually cuts across the rings of annual growth.

(3) *Decay.*—Disintegration by wood-destroying fungi. In the incipient stage the wood is not perceptibly softened, but in the typical or advanced stage, it is recognizably punky, soft and spongy, stringy, pitted, or crumbly.

(4) *Hole.*—A hole, from any cause, extending partly or entirely through the piece.

(5) *Knot.*—That part of a limb which has become incorporated in the body of a tree. If it is solid across its face and as hard as the surrounding wood, it is *sound*; if it has grown soft, it is *decayed.* If the rings have become linked with those of the surrounding wood, it is

intergrown; otherwise, it is *encased*. It may be called a *round* or a *spike* knot, according to its apparent shape when sawed.

(6) *Shake.*—A crack along the grain, mostly between the rings of annual growth.

(7) *Split.*—A lengthwise tearing apart of the wood cells.

(8) *Stain.*—Any change from the natural color of the wood.

(9) *Wane.*—The missing or defective part of an imperfect board, such as bark along the edge or corner.

(10) *Manufacturing defects.*—Manufacturing defects include all damage to the wood in manufacture, such as chipped grain, machine burn, or machine gouge.

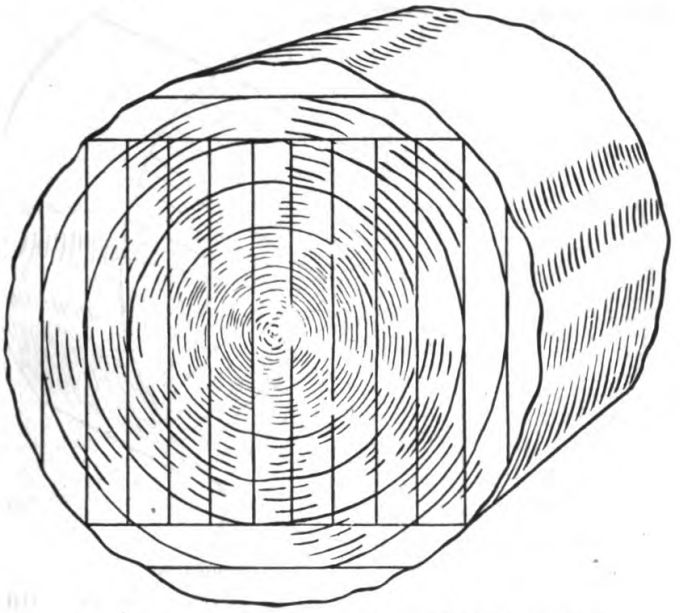

FIGURE 3.—Plain, "flat," or "slash" sawing.

5. Manufacture of lumber.—*a. Sawing.*—Lumber can be cut from a log in two distinct ways:

(1) Tangent to the annual rings, producing plain-sawed lumber in hardwoods and flat-grain or slash-grain lumber in softwoods.

(2) Radially, or parallel to the rays, producing quarter-sawed lumber in hardwoods and edge-grain or vertical-grain lumber in softwoods. Plain sawing is illustrated in figure 3. The pieces sawed off the outside sapwood to square the log, known as "slabs," are not ordinarily used for lumber. Lumber may be quarter-sawed in any of the four ways illustrated in figure 4, at the discretion of the sawyer. Quarter-sawed lumber often has not only a handsomer surface than plain-sawed, but also holds its shape better. Boards shrink most in a direction parallel with the annual rings; hence radial sawing, which cuts across the rings, holds warping to a minimum.

b. Seasoning.—Seasoning is simply the evaporation of sap and moisture from green wood, either naturally or artificially. The drier the lumber, the less likely it is to decay or shrink. Figure 5 shows two kinds of lumber piles for air seasoning. Since air seasoning takes approximately a year for each inch of the lumber's thickness, most lumber today is kiln-dried, that is, dried in a room or bin kept artificially at a temperature of about 100° F. Kiln-dried lumber seasons in 60 to 90 days, depending upon its size. Although air-seasoned lumber is better, the length of time and equipment required make its use nearly prohibitive.

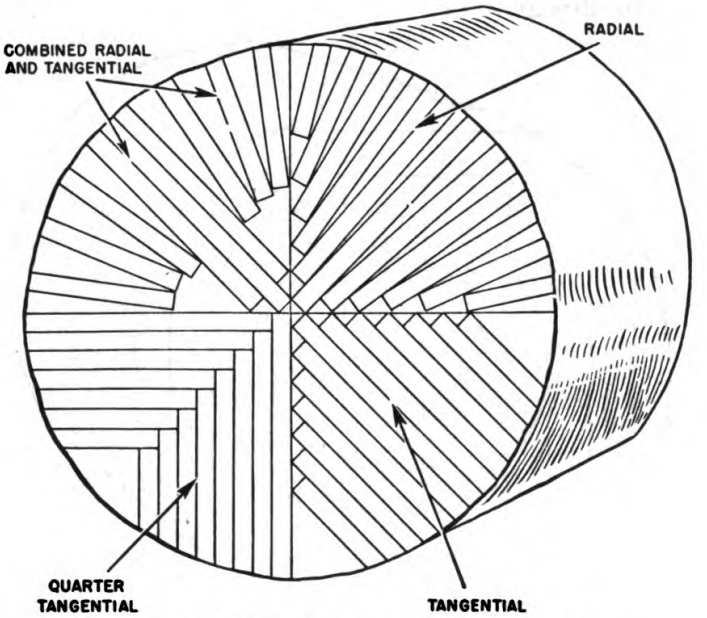

FIGURE 4.—Four methods of quarter-sawing.

c. Grading.—(1) Some species of wood have many varieties, and even the wood from two trees of the same variety may differ considerably in physical properties because they have different kinds of defects or grew in different climates. The lumber manufacturers' associations have many rules for grading lumber according to the defects and dimension tolerances allowable. Rather than purchase lumber according to the manufacturer's grading, however, some consumers have formulated their own specifications.

(2) A typical Army specification follows:

"Wood used in the body shall be white or red oak, or white cane ash, thoroughly dried to not more than ten (10) percent moisture content. It shall be straight-grained, free of imperfections that impair its strength, durability or appearance, and must have no rough surfaces or checks at the edges that may splinter and injure occupants of seats. The wood must be thoroughly treated against dry rot with

an effective preservative at least equal to 'Wood Life' or 'Permatol' and shall be primed with a long-oil primer sealer, before painting. The wood must withstand continuous exposure to weather under varying climatic conditions, without evidence of dry rot setting in during the guarantee period."

d. Plywood.—(1) Plywood is a board built up of laminated veneers or plies, with the grains of adjacent pieces at right angles to each other. The alternating direction of the grain in the plies equalizes strains and thus minimizes shrinkage and warping of the product and prevents splitting. Kiln-dried veneers are glued together under high pressure, making the joints as strong as the wood itself or stronger.

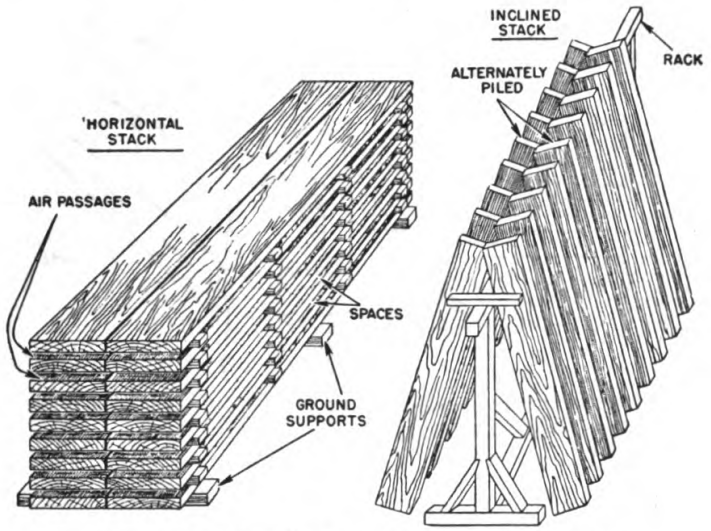

FIGURE 5.—Lumber piled for air seasoning.

The glue is graded from moisture-resistant to waterproof. Plywood made from hardwood veneers or with a hardwood finish is available, but the most usual type is Douglas fir.

(2) Plywood has been used in late years for motor vehicle work as well as for paneling, sheathing, concrete forms, cabinet work, and many other structural and industrial uses, because it is much stronger than ordinary lumber of the same thickness and is not limited in width by the size of the tree trunk. It is available in sizes up to 4 by 8 feet; standard thicknesses range from $\frac{3}{16}$ to $\frac{7}{8}$ inch, or three to seven plies.

e. Measurement of lumber.—(1) *General.*—(*a*) Lumber is measured according to a system known as "board measure" (bm). The unit is a board foot, which is equal in volume to a board 1 foot wide, 1 foot long, and 1 inch thick, or 144 cubic inches. To compute board measure, if the board is less than 1 inch thick, consider the fraction as a full inch. If it is thicker than 1 inch, however, figure the inches and

fractions of an inch exactly. Thus a ½-inch board is considered as 1 inch thick bm but a 1½-inch board as 1½ inches.

(*b*) Board sizes are rough-green, or nominal, dimensions, which are considerably greater than the actual measurements of dressed lumber. The amount removed in dressing varies with the board size. For example, a 1- by 3-inch board measures $^{25}/_{32}$ by 2⅝ inches dressed; a 1½- by 12-inch board measures $1^{15}/_{16}$ by 11½ inches dressed.

(2) *Computation.*—To compute board feet, multiply the length of the board in feet by the width in feet and multiply this product by thickness in inches. Do not forget that thickness less than 1 inch is counted as 1 inch, but fractional inches over 1 are counted in fractions.

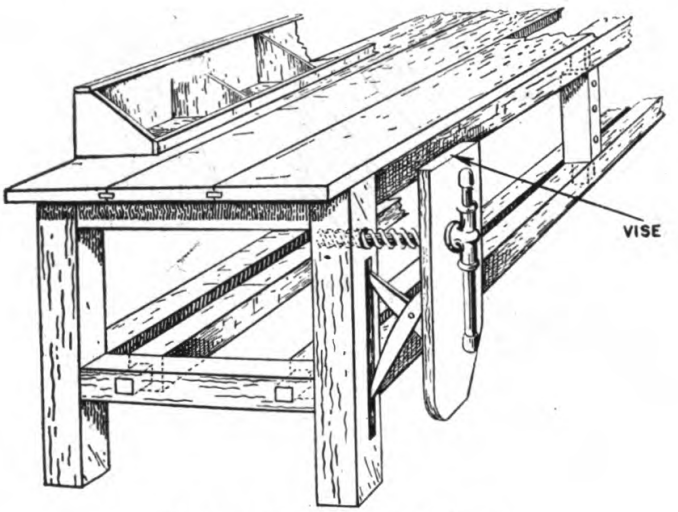

FIGURE 6.—Carpenter's bench.

(3) *Examples.*—(*a*) How many board feet in a board 12 feet long by 18 inches wide by 1¾ inches thick?

18-inch width = (18 ÷ 12) feet = 1.5 feet

12 × 1.5 × 1¾ = 31.5 board feet

(*b*) How many board feet in the board of the previous example if it were only ½ inch thick?

12 × 1.5 × 1 = 18 board feet (bm)

6. Bench.—For woodworking by hand, a suitable work bench is an absolute necessity. Most people find a top surface about 27 inches wide and 34 inches above the floor to be convenient, but one should use a bench with these dimensions modified to give a comfortable position for the particular work being done. The length depends on the space available and the size of the work. The surface should be made of flat, thick planking, scraped and then shellacked or oiled to increase its life, and the entire bench well braced to support the work firmly. Such a bench is illustrated in figure 6.

a. Vise.—The bench should be equipped with a vise similar to that shown in figure 6 or figure 7, at the left end of the bench and preferably on the overhang, where it provides rigid support for sawing off boards just beyond the end of the bench. Drawers, bins, or pigeon-

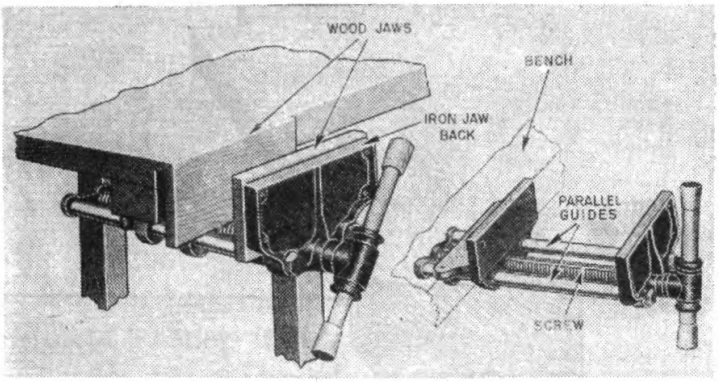

FIGURE 7.—Carpenter's vise.

holes, as shown in the figure are convenient for holding materials, tools, or work in progress.

b. Bench stop.—A bench stop to prevent a board from moving endwise while it is being planed should be mortised into the bench, preferably near the left end. The two types illustrated in figure 8 are adjusted flush with the top of the bench when not in use. A

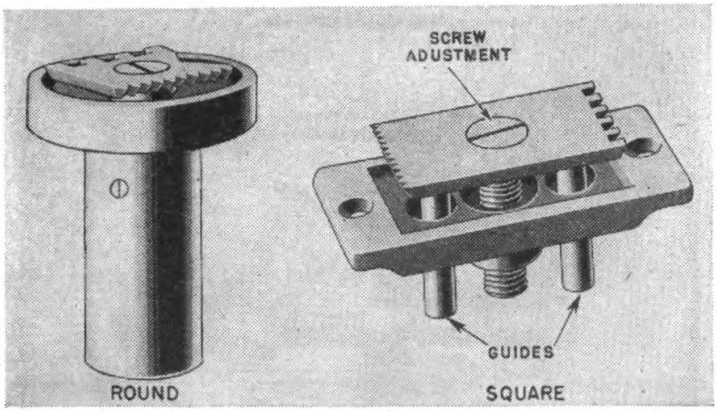

FIGURE 8.—Bench stops.

bench stop can be made from a block of hardwood about 2 inches square, but a toothed metal one holds the work more securely.

c. Bench hook.—As in most processes, one can get good results in woodworking only when the equipment is clean and well cared for. Bench tops should not be marked or scratched unnecessarily. When working with a chisel or small saw, use a chisel board or bench hook (fig. 9) to protect the top from accidental cuts.

d. Clamps.—Clamps are very necessary in the woodworking shop, particularly to keep glued joints under pressure while the glue is setting. They have many other uses, such as holding pieces in posi-

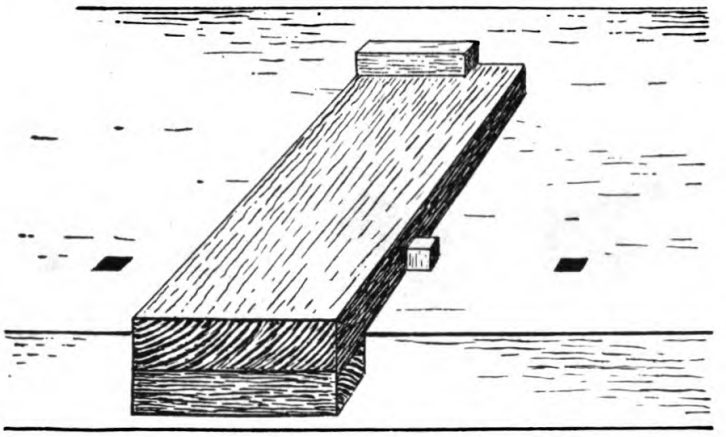

FIGURE 9.—Bench hook or chisel board.

tion while they are being fastened together or cut to the same size and shape. A C-clamp and a beam clamp are illustrated in figure 10.

7. Woodworker's lay-out tools.—Woodwork is planned and laid out with instruments like those used in metal work, but greater tol-

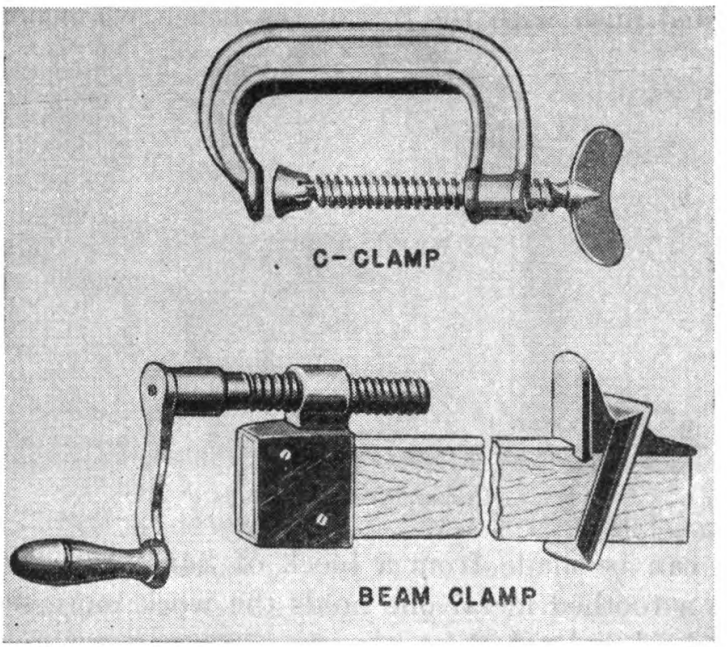

FIGURE 10.—Clamps.

erances are permissible, and micrometer measurements are unnecessary. All measurements in woodwork depend on the eye for accuracy. The ordinary lay-out tools include the following:

a. Pencil and knife.—Used for marking lines on the work.

b. Carpenter's rule (fig. 11).—Usually made of boxwood and used for most measurements. It is 2 feet long, and hinged to fold to 6 inches. For measurements more than 2 feet, raise the rule and move it along, or substitute a 6-foot jointed rule or a measuring tape. To

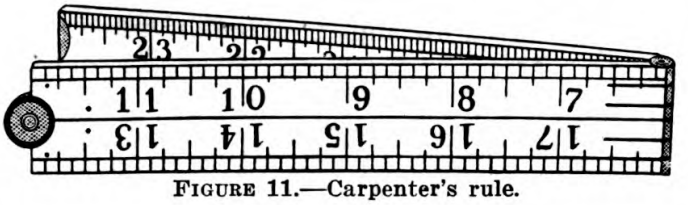

FIGURE 11.—Carpenter's rule.

lay out a long, straight line, fasten a chalked string taut in the position of the desired line, and snap it against the work.

c. Try square (fig. 12).—Used for laying out lines at right angles to an edge or surface and for testing squareness. The usual try square has a blued-steel blade, graduated in inches and eighths, and a brass-

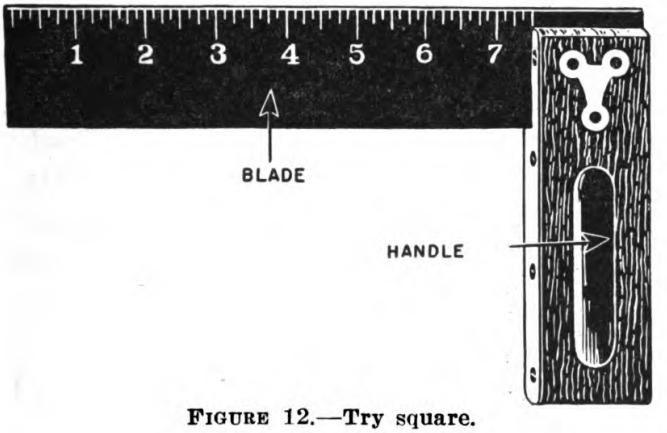

FIGURE 12.—Try square.

faced rosewood handle. The blade is square with the handle, inside and out.

d. Combination square (fig. 13).—Can be used for the same purposes as the try square, but the head slides along the blade, where

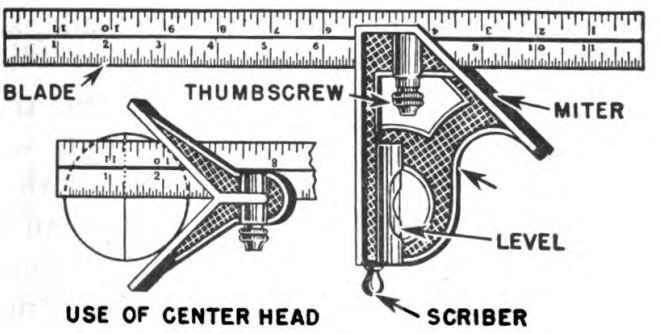

FIGURE 13.—Combination square.

it is clamped in any position by a thumbscrew; hence it can be used to test the depths of mortises and the like. Combined with the square is a level and a 45° bevel, or miter. The blade can be pulled out and used as a rule. A scriber, for scratching lines, is held in a split brass bushing in the head. The insert in figure 13 shows the blade inserted in a center head to locate centers on round work. Scribe two diameters approximately at right angles to each other; the intersection is the center.

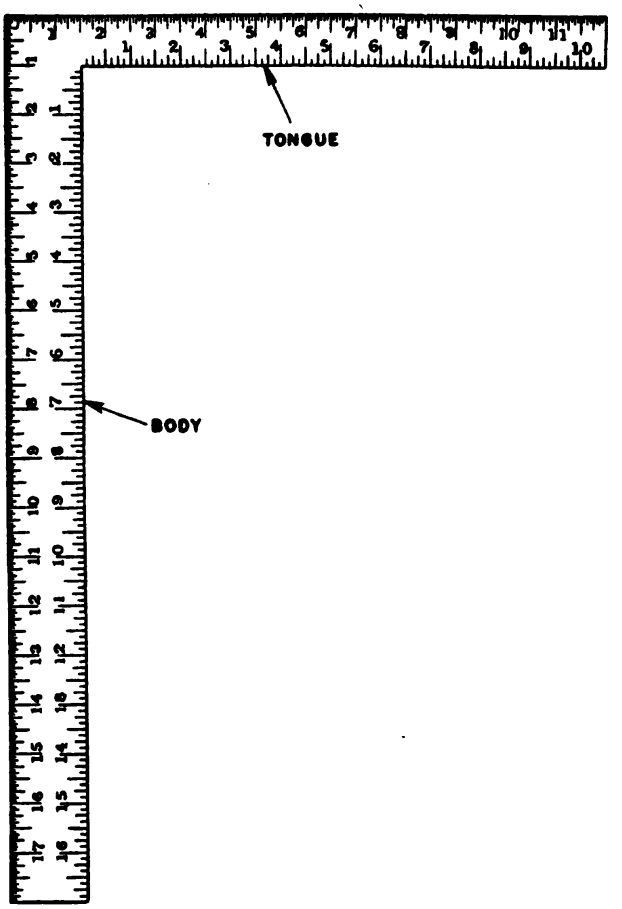

FIGURE 14.—Carpenter's steel square.

e. Carpenter's steel square (fig. 14).—Used for larger work. The longer and wider part is called the body, or blade, and the shorter and narrower part is called the tongue.

f. Bevel (fig. 15).—Similar in construction to the try square. The adjustable blade, however, can be set at any angle with the handle, but it is not graduated. Use the bevel instead of the try square or combination square for laying out angles other than 90° and 45°.

g. Marking gage (fig. 16).—Usually made of boxwood or beech and consists of a graduated bar, a head with a locking thumbscrew, and a

scriber, or point. This tool is used for marking light but distinct lines parallel to the edge of the work. Some marking gages scribe two parallel lines simultaneously and others have small marking wheels instead of scribers.

h. Dividers (fig. 17).—Used for laying out circles, dividing a line into equal parts, and transferring dimensions. Both legs are sharpened to points. A rule is used to set the dividers for a specific dimension.

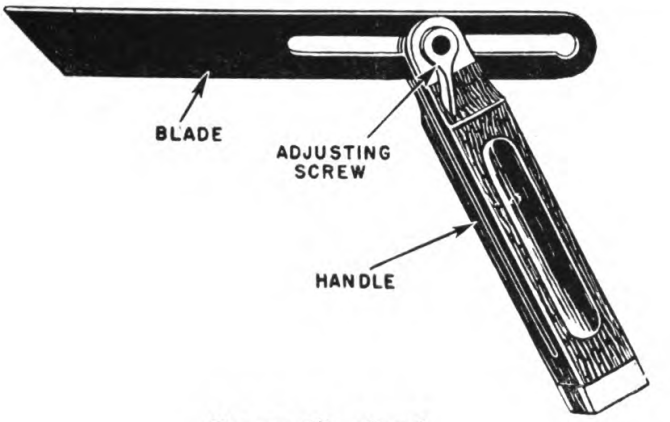

FIGURE 15.—Bevel.

i. Carpenter's level (fig. 18).—Sometimes known as a spirit level and is used largely for laying out horizontal and vertical lines and for determining whether surfaces or edges are level (horizontal) or plumb (vertical). About 12 to 30 inches long, the level is usually made of aluminum or wood. Readings are taken by placing it against the sur-

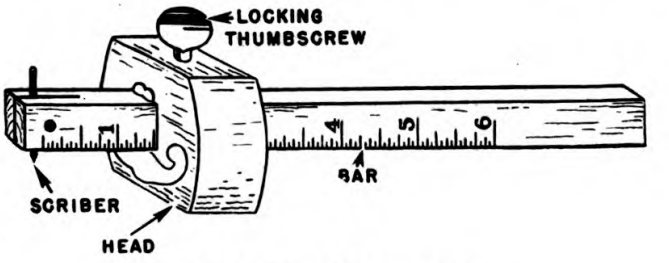

FIGURE 16.—Marking gage.

face to be tested. If the surface is level, or plumb, bubbles will be centered in the liquid in one or two of the curved glass tubes.

j. Plumb bob (fig. 19).—The plumb bob is suspended on a line, unwound from a reel, to determine a long vertical.

8. Hand tools for woodworking.—Hand tools for woodworking include the following:

a. Carpenter's hammer (fig. 20).—Used for driving and withdrawing nails and has a forged steel head and hickory handle. Ordinarily

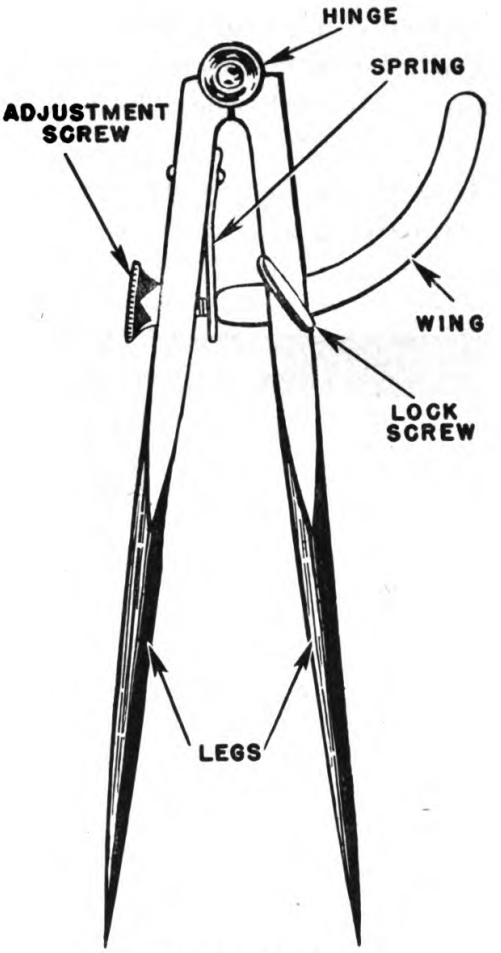

FIGURE 17.—Dividers.

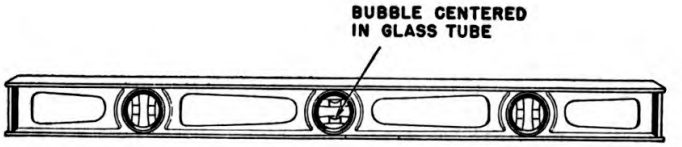

FIGURE 18.—Carpenter's level.

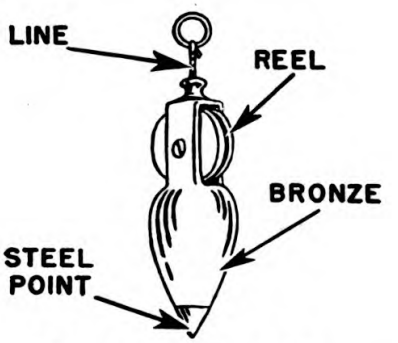

FIGURE 19.—Plumb bob.

the face is flat, but it may be slightly rounded for sinking nailheads slightly below the surface of rough wood. To withdraw nails without enlarging the hole and without marring the work, use a block of wood under the claw.

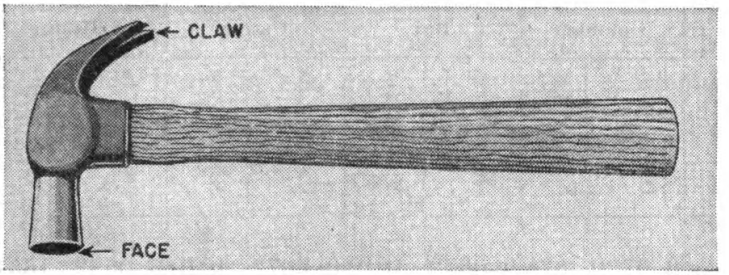

FIGURE 20.—Carpenter's hammer.

b. Wire nails (fig. 21).—Common types of wire nails are available with or without cement coating which gives them superior holding power. The "penny" system is used in designating nail sizes; for example, a 10-d (10-penny) nail is 3 inches long. Table I gives the dimensions and number per pound of common, box, casing, and finishing nails and brads.

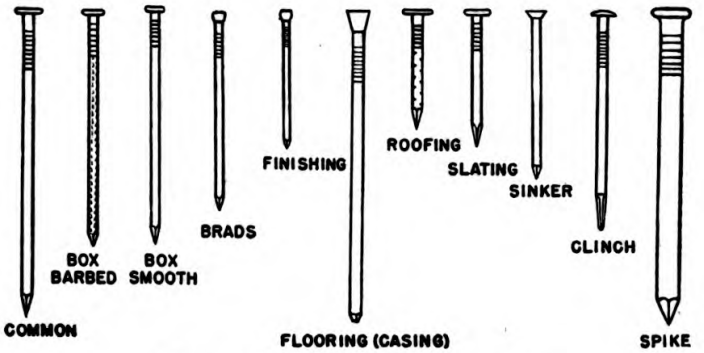

FIGURE 21.—Common wire nails.

c. Nail set (fig. 22).—Has a cup-shaped end and is generally used for driving the small heads of finishing nails, brads, and casing nails below the surface of the wood. Hammer the nail almost flush with the surface of the wood; then, with the cup-shaped end over the nailhead, hammer the nail set. Thus the surface of the wood will not

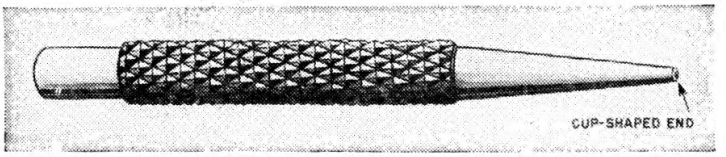

FIGURE 22.—Nail set.

be dented. The holes where the nails have been countersunk are later filled with putty.

TABLE I.—*Nail dimensions and weights*

Penny No.	Length	Common		Box		Casing		Finishing		Brads	
		Diameter in inches	Number per pound	Diameter in inches	Number per pound	Diameter in inches	Number per pound	Diameter in inches	Number per pound	Diameter in inches	Number per pound
2	1	0. 0720	876	0. 0672	1010	0. 0672	1010	0. 0582	1351	0. 0720	876
3	1¼	. 0800	568	. 0760	635	. 0760	635	. 0672	807	. 0800	568
4	1½	. 0985	316	. 0800	473	. 0800	473	. 0720	584	. 0985	316
5	1¾	. 0985	271	. 0800	406	. 0800	406	. 0720	500	. 0985	271
6	2	. 1130	181	. 0985	236	. 0985	236	. 0915	309	. 1130	181
7	2¼	. 1130	161	. 0985	210	. 0985	210	. 0915	238	. 1130	161
8	2½	. 1314	106	. 1130	145	. 1130	145	. 0985	189	. 1314	106
9	2¾	. 1314	96	. 1130	132	. 1130	132	. 0985	172	. 1314	96
10	3	. 1483	69	. 1277	94	. 1277	94	. 1130	121	. 1483	69
12	3¼	. 1483	64	. 1277	87	. 1277	87	. 1130	113	. 1483	64
16	3½	. 1620	49	. 1350	71	. 1350	71	. 1205	90	. 1620	49
20	4	. 1920	31	. 1483	52	. 1483	52	. 1350	62	. 1920	31
30	4½	. 2070	24	. 1483	46	. 1483	46	------	-----	. 2070	24
40	5	. 2253	18	. 1620	35	. 1620	35	------	-----	. 2253	18
50	5½	. 2437	16	------	-----	------	-----	------	-----	. 2437	16
60	6	. 2625	11	------	-----	------	-----	------	-----	. 2625	11

d. Screw drivers (fig. 23).—Available in plain, ratchet, and spiral types, for both slotted-head and Phillips screws. With a ratchet

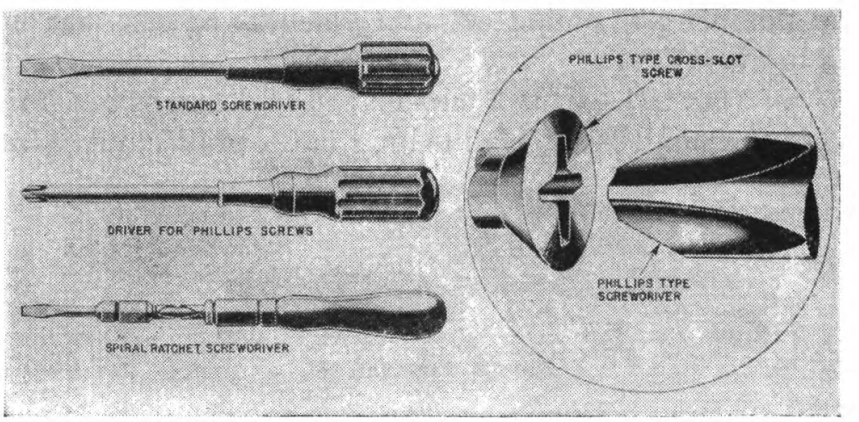

FIGURE 23.—Screw drivers.

screw driver, it is possible to turn the screw in one direction without shifting the grip on removing the screw driver from the screw.

When the hand will not go any farther, and the handle is turned in the other direction, the screw does not turn. With a spiral screw driver, one can turn a light screw rapidly by just pushing the screw driver handle. Heavy screws are often driven with a screw driver bit inserted in a brace.

e. Wood screws.—(1) Common types of wood screws are shown in figure 24. Various lengths can be had in each diameter, which is

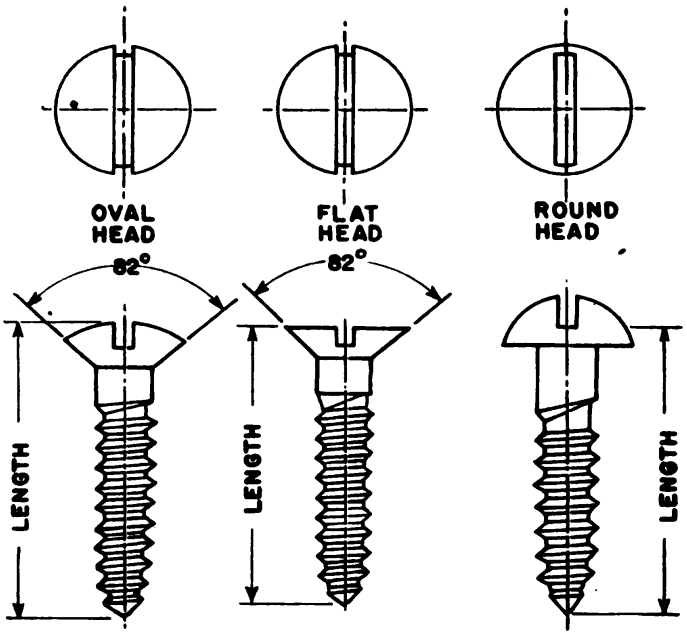

FIGURE 24.—Common wood screws.

designated by a number. When ordering screws, specify the number and the length. Table II gives the dimensions (except length) of wood screws according to number.

TABLE II.—*Wood screws (American standard)*

Screw No.	Body diameter	Diameter of round-head	Diameter of flat-head	Screw No.	Body diameter	Diameter of round-head	Diameter of flat-head
0	0. 060	0. 106	0. 112	9	0. 177	0. 322	0. 346
1	. 073	. 130	. 138	10	. 190	. 347	. 372
2	. 086	. 154	. 164	11	. 203	. 370	. 393
3	. 099	. 178	. 190	12	. 216	. 394	. 424
4	. 112	. 202	. 216	14	. 242	. 442	. 476
5	. 125	. 226	. 242	16	. 268	. 490	. 528
6	. 138	. 250	. 268	18	. 294	. 539	. 580
7	. 151	. 275	. 294	20	. 320	. 587	. 632
8	. 164	. 298	. 320	24	. 372	. 683	. 736

The flathead and oval countersunk screws have heads of the same diameter for each size.

(2) To screw two pieces of wood together (fig. 25)—

(*a*) Lay out the screw holes.

(*b*) Bore the holes in the first piece of wood, just slightly larger than the diameter of the screw shank.

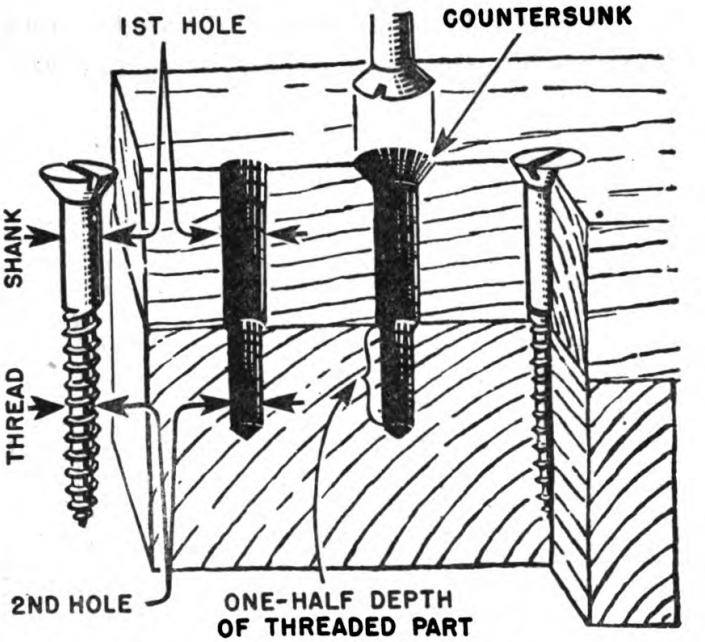

FIGURE 25.—Holes for screwing two pieces of wood together.

(*c*) Bore the holes in the second piece of wood, slightly smaller than the threaded part of the screws, and half as deep.

(*d*) Countersink the first holes to match the diameter of the screw heads.

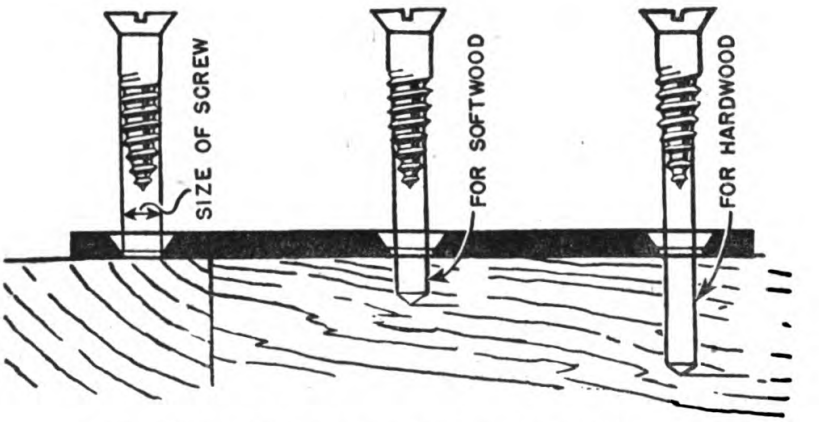

FIGURE 26.—Holes for mounting hardware with screws.

(*e*) Drive the screws tightly in place with the screw driver.

(3) To fasten hinges or other hardware with screws (fig. 26)—

(*a*) Locate the hardware on the wood.

(*b*) Recess the work to receive the hardware, if necessary.

(*c*) Lay out the screw holes.

(*d*) Select screws that will pass easily through the holes in the hardware.

(*e*) Bore the pilot holes (second holes) slightly smaller than the diameter of the threaded part of the screw.

(*f*) Drive the screws tightly in place.

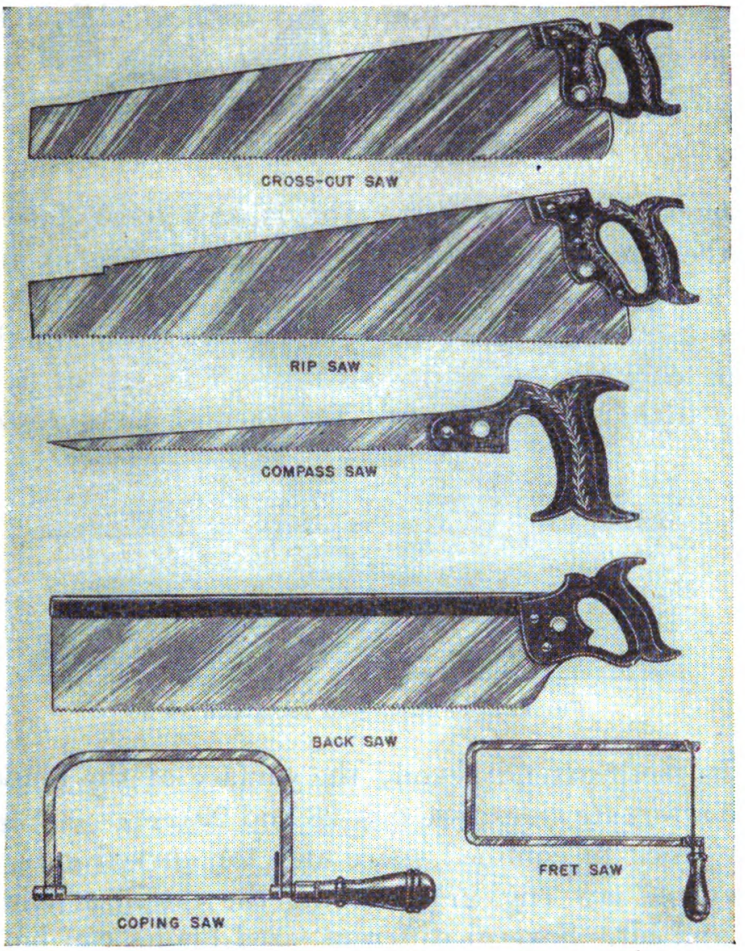

FIGURE 27.—Common hand saws.

(4) If the wood is soft, bore as deep as half the length of the threaded part of the screw, as shown in figure 26. If the wood is hard (oak for example), or the screw is large or soft (brass for instance), the hole must be nearly as deep as the screw. Holes for small screws are usually made with brad awls or drills. Soaping the threads will make the screw drive more easily.

f. Saws.—(1) The common hand saw consists of a thin, flat blade of tool steel having a row of teeth along one edge and wooden handle screwed to the large end. There are several common types of hand

saws (fig. 27), but all are classified as "crosscut" saws or "ripsaws." A crosscut saw cuts across the grain and a ripsaw cuts with the grain. On a crosscut saw the teeth are filed on alternate sides, producing beveled cutting edges like a series of little knives (fig. 28). On a ripsaw, each tooth is filed straight across the face to a sharp square

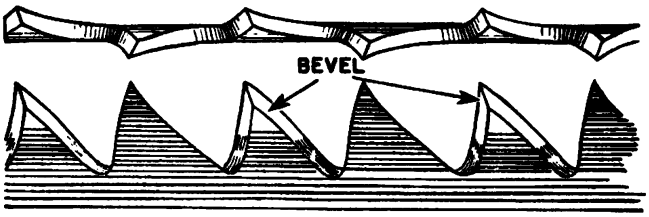

FIGURE 28.—Crosscut teeth (enlarged view).

slightly steeper than the back. The ripsaw tooth face is at right angles to the line of the teeth. The angles of crosscut and rip teeth are shown in figure 30.

(2) Saw teeth are "set" to prevent the saw from binding and the teeth from choking up with sawdust. The set of a saw is the edge like a little chisel (fig. 29). The face of each crosscut tooth is

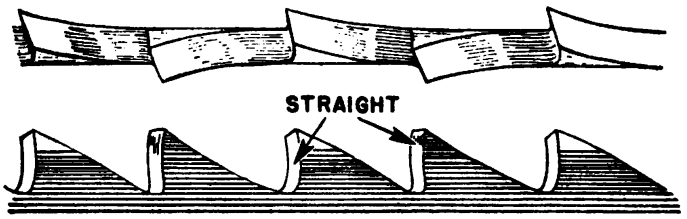

FIGURE 29.—Rip teeth (enlarged view).

distance the teeth extend beyond the surface of the blade; the teeth are bent to alternate sides (see figs. 28 and 29).

(3) For work in confined space and for curved cuts, use a compass or keyhole saw (fig. 27), starting the cut in a hole bored with the brace and bit. Several different sized blades can be used in the same handle. For more intricate work, "coping" and "fret" saws are used.

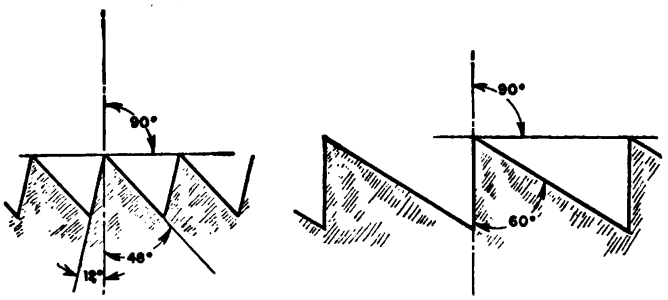

FIGURE 30.—Angles of crosscut and rip teeth.

(4) The backsaw has a rigid back which prevents the saw from bending. It is used freehand for accurate work, such as cutting out tenons, or in a miter box (fig. 31), for making accurate cuts at any angle.

(5) The size of a saw is the length of the blade in inches. Coarse teeth are used for softwood and fast work, and fine teeth for hardwood and smooth cuts. A ripsaw having about 5½ teeth or points per inch will work rapidly and easily in pine and other softwoods. A 6-point saw should be used for ripping mahogany, cherry, or other hardwoods. A crosscut saw for ordinary work should have 5 or 6 points to the inch; but 10 or 12 points are better when working exclusively on dry woods, either soft or hard.

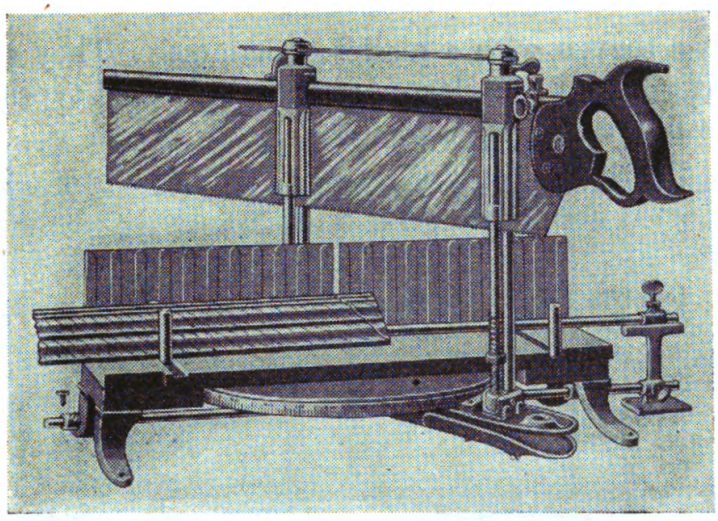

FIGURE 31.—Miter box.

(6) All sawing wastes as much wood as the width of the cut, or kerf. Therefore, always cut about 1/16 inch outside the dimension lines, leaving enough margin for subsequent planing or finishing of the rough sawed surfaces.

g. Chisels.—(1) A chisel is a flat piece of hardened and tempered tool steel with an acutely beveled cutting edge at one end and a wooden handle at the other. Usually from ⅛ to 2 inches wide, chisels are classified by blade length as butt, pocket, and mill, about as follows: butt, 2½ to 3¼ inches; pocket, 4 to 5 inches; mill, 8 to 10 inches. Chisels more than 2 inches wide are known as "slicks."

(2) Chisels are divided into three classes, according to duty: paring, firmer, and framing chisels (fig. 32). Paring chisels are the lightest, have a wooden handle usually held on a tang (figs. 32 and 33), are used only for taking light cuts, and are always driven by hand pressure. Firmer chisels, which have tang or socket handles,

driven by hand pressure or by strokes of a wooden mallet, are used in work such as light and medium mortising. Framing chisels have socket handles, sometimes fitted with iron rings to prevent them from

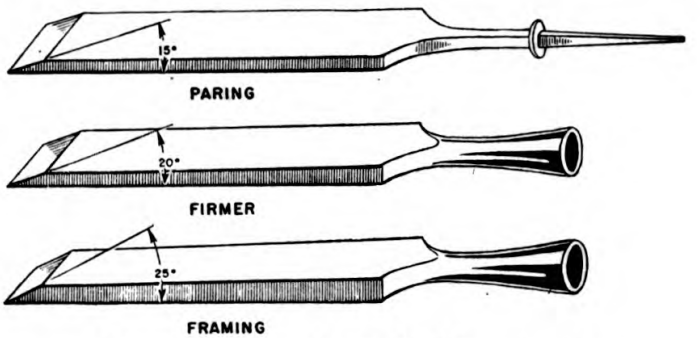

FIGURE 32.—Chisels classified by purpose.

splitting when driven with a mallet or hammer. They are required for such work as large and deep mortising. Special types of handles are shown in figure 33.

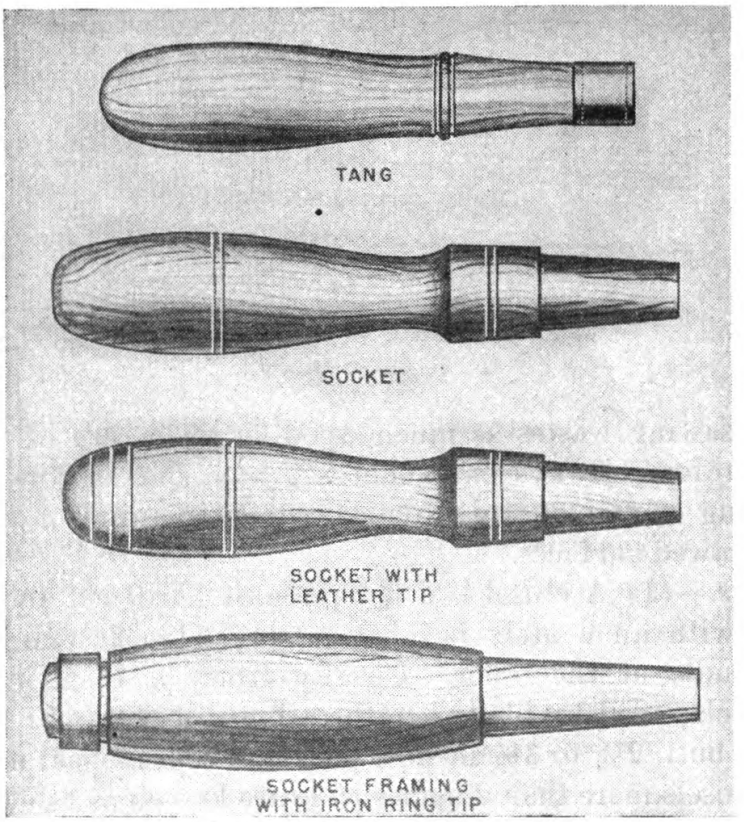

FIGURE 33.—Chisel handles.

(3) Curved chisels (fig. 34) for scooping or cutting grooves are known as gouges; the bevel is ground on the inside of paring gouges and on the outside of firmer gouges.

(4) If a chisel is driven too deeply into the wood, the wood cannot be chipped without extra pressure. Do not use a firmer chisel for mortising heavy timber. Keep chisels bright and sharp at all times. Protect the cutting edge when not in use. Never abuse a wood chisel by opening boxes, cutting metal, or driving screws with it.

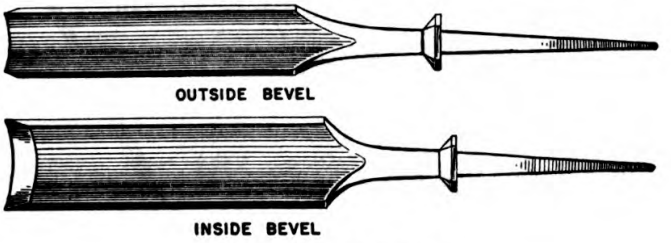

FIGURE 34.—Gouges.

h. Planes.—(1) A plane (fig. 35) is a tool for shaving wood surfaces to smooth them, reduce them, or change their shape. It has a wooden or iron bottom with a 30° beveled iron projecting through a slot in its under side. The plane iron, also known as "blade" or "cutter," inclines backward, so that it scoops shavings up through the slot as it cuts. A cutter cap breaks the chips and a lever cap holds the cutter cap and iron in place. The iron and cap can be fed down

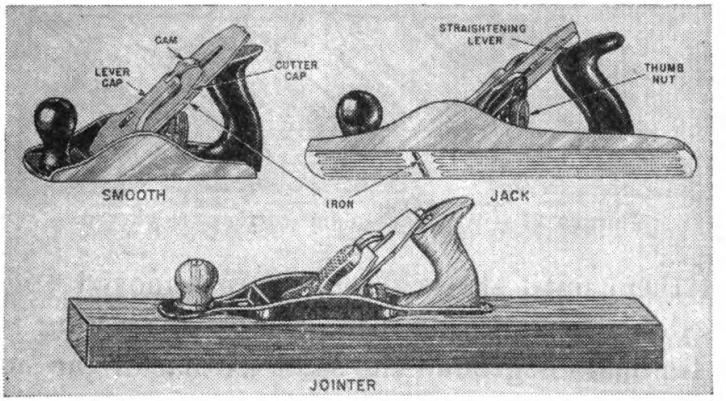

FIGURE 35.—Three types of bench planes.

or withdrawn through the slot by a thumb nut and straightened by a lever. The iron and cutter cap are removed from the plane by moving the cam and taking out the lever cap.

(2) Most bench planes are classified as smooth, jack, fore, and jointer, three of which are illustrated in figure 35. Iron bottoms are more durable but many beechwood bottoms are still in use. Some iron bottoms are grooved to reduce friction.

(*a*) The smooth plane, 5½ to 10 inches long, follows the contour of the wood. The corners of the blade are rounded slightly to avoid tearing; it cuts lightly and gives a very smooth surface.

(*b*) The jack plane, about 11½ inches long, is used to remove stock rapidly, and therefore the iron is ground to a slight curve (fig. 36) to avoid the ragged edges clearly shown in figure 37. Jack planes

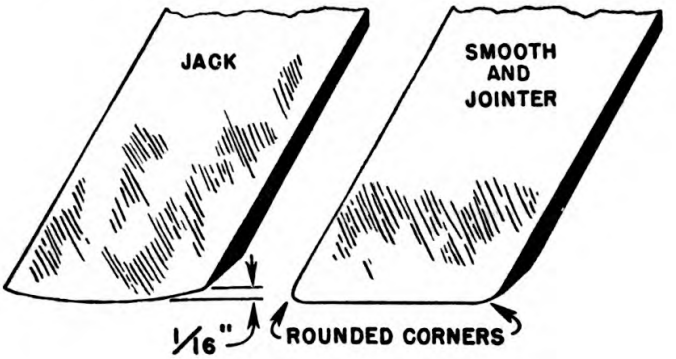

FIGURE 36.—Plane irons.

are used for removing saw marks, truing the edges of a board, and rapidly preparing the surface for the smooth plane.

(*c*) The jointer is from 22 to 26 inches long. Instead of following the contour of the wood, this long plane bridges the low parts and

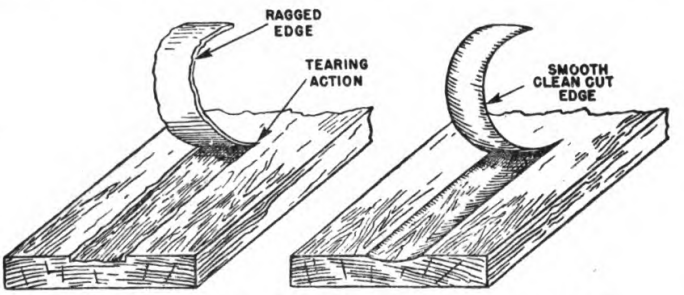

FIGURE 37.—Why jack plane cutters are curved.

does not cut them until the high spots are removed (fig. 38). The jointer is used for long work and especially for truing two edges to be joined. Its blade is ground the same as that of the smooth plane.

(*d*) The fore plane is simply a short jointer. Jointer or fore planes are not required when a machine jointer (par. 10*d*) is available.

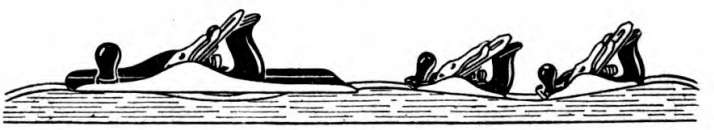

FIGURE 38.—Jointer straightens curved surfaces; smooth plane follows them.

(3) Almost every plane iron has a cutter cap, or chip breaker, fastened to it by a screw, curved at the end near the cutting edge of the iron (fig. 39). The cap is ordinarily adjusted about ⅛ inch back of the cutting edge for a jack plane and about 1/32 inch for a

smooth plane, but for cross or curly grain these distances are cut in half. Always push the plane with the grain, when possible, and keep the plane straight at the beginning and end of the stroke (see fig. 40) by pressing down on the knob at the beginning of the stroke and on

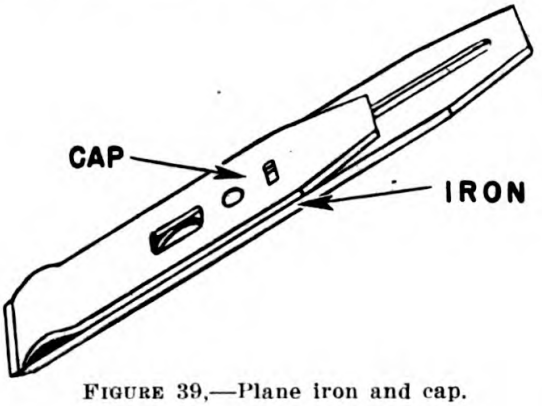

FIGURE 39.—Plane iron and cap.

the handle at the end of the stroke. Avoid lowering the plane as shown by the dotted lines, or the planed surface will be curved at the ends. The plane iron will stay sharp much longer if the handle of the plane is raised on each return stroke, so that the cutting edge does not touch the work.

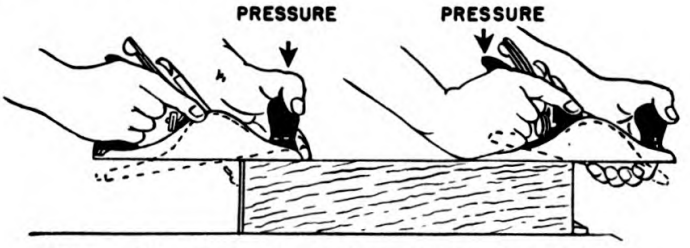

FIGURE 40.—Cut with grain and keep plane straight.

(4) The block plane (fig. 41), from 3½ to 7½ inches long, is the smallest plane made. It can be held in one hand for planing across

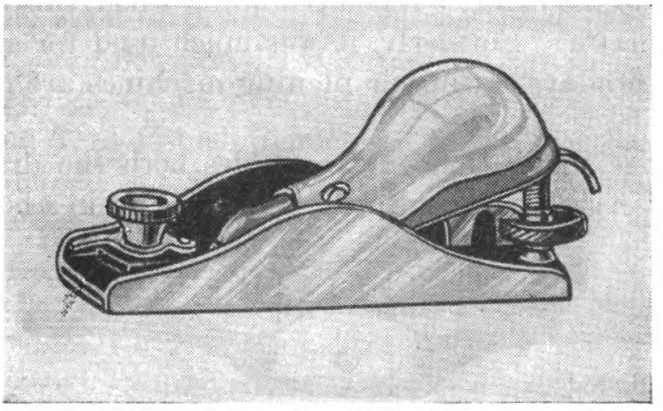

FIGURE 41.—Block plane.

the grain, particularly at the end of a board. It has no cap to break the shavings, since there are no shavings; usually the end grain becomes almost a powder. The bevel of the plane iron is turned up, instead of down as in the planes discussed above. In planing the end of a board, lift the block plane before the end of the cut (fig. 42), to avoid splitting the board at the edge. Work from alternate ends, taking a few cuts at a time from each direction.

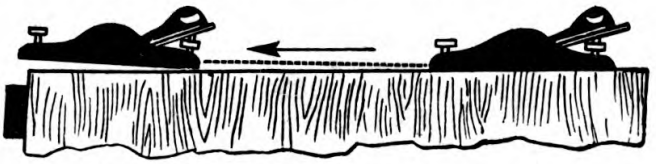

FIGURE 42.—Block planing across grain.

(5) There are many types of special-purpose planes for cutting grooves and moldings, as well as a router plane, which projects a blade as much as half an inch below the plane bottom to smooth the bottom of a groove or other depression. The commonest of the special planes is the "rabbet," or "rebate," plane, which planes in corners and cuts grooves, steps, or laps in the edge of a board.

i. Drawknife and spoke shave.—(1) The drawknife (fig. 43) consists simply of a large, sharp-edged blade having at each end a handle

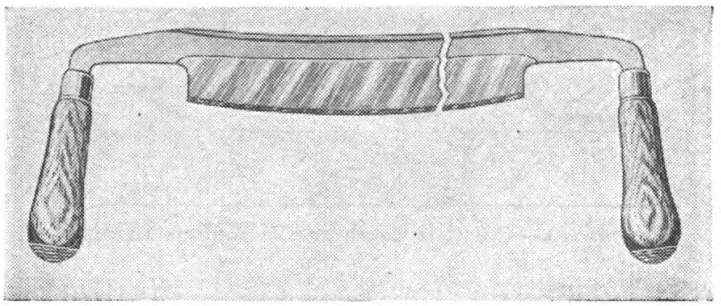

FIGURE 43.—Drawknife.

at right angles to the blade. When trimming wood, this tool is drawn toward the operator. Formerly, it was much used for shaving wood rapidly, but nowadays sawing or planing machines are preferred for this work.

(2) The spoke shave (fig. 44) resembles both the drawknife and the plane. As in a plane, an adjustable blade is set in a box-like frame

FIGURE 44.—Spoke shave.

which guides it, but the tool is held like a drawknife. Spoke shaves are made in a variety of designs with straight and curved blades and with metal or wood bottoms. Wood bottoms, however, are preferred for working softwood because they do not mar it. Before the invention of automatic spoke-making machines, spoke shaves were used extensively for fashioning wagon wheel spokes; hence the name. They are still very useful for rounding and smoothing irregular surfaces.

j. Hand boring and drilling tools.—Boring tools generally used in the woodworking shop are the bit brace and the hand drill (fig. 45).

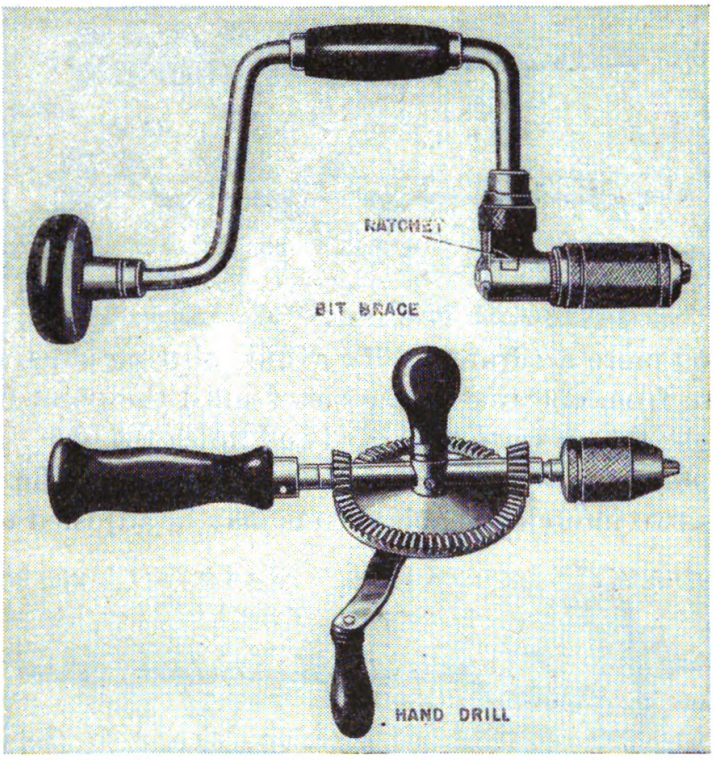

FIGURE 45.—Bit brace and hand drill.

(1) The hand drill is quick and convenient for small holes. The most desirable style of brace is the ratchet type (fig. 45), because it is possible to bore holes or drive screws with it in tight spots where there is not enough room for the full sweep of the brace. Braces range in sweep from 6- to 14-inch diameter. A brace with an 8-inch sweep is most convenient for boring 1-inch or smaller holes in softwood. For larger holes, especially in hardwood, use a brace with a 10- or 12-inch sweep.

(2) Wood boring bits are made in many styles. The most important are the auger bits, three of which are shown in figure 46. These are available in sizes measured in sixteenths of an inch from $\frac{3}{16}$ to 1 inch. (*Example:* A No. 4 bit is $\frac{4}{16}$ or $\frac{1}{4}$ inch in diameter, and a No. 7 bit is

7/16 inch.) The single-twist auger bit has one spur and one cutting lip. It works somewhat faster and easier than the double-twist bit, which has two of each, but the double-twist does a smoother job. As the brace is turned, the screw draws the bit into the work, boring at a speed regulated by the pitch of the screw thread. A coarse pitch works fast, but a finer pitch is preferred by cabinet makers because it bores

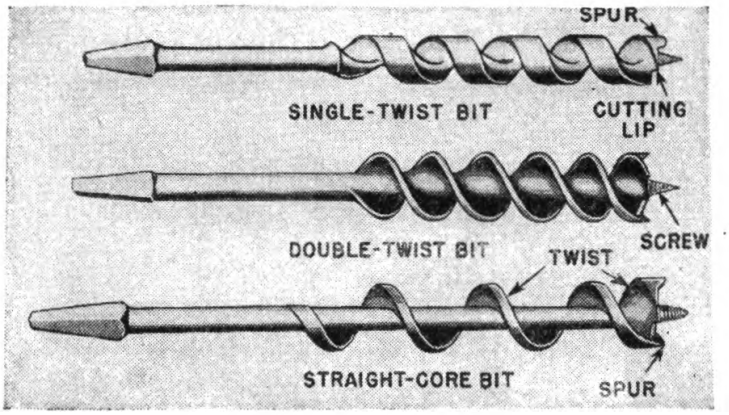

FIGURE 46.—Auger bits.

seasoned wood more accurately. To avoid splitting out the bottom of the hole, bore from one side of the board until the point of the screw comes through; then reverse the board and finish the hole.

(*a*) For holes larger than 1 inch, the extension bit (fig. 47) is convenient. Its two interchangeable cutters may be adjusted to bore holes

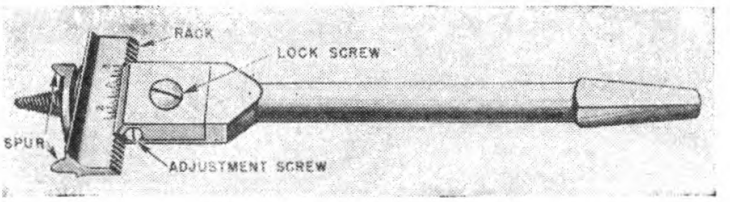

FIGURE 47.—Extension bit.

of any size from 7/8 inch to 3 inches in diameter. Each cutter consists of a spur and rack, held in place by a lock screw.

(*b*) To enlarge the upper part of a hole in the shape of a cone for countersinking a flatheaded screw, use a countersink (fig. 48) in the brace.

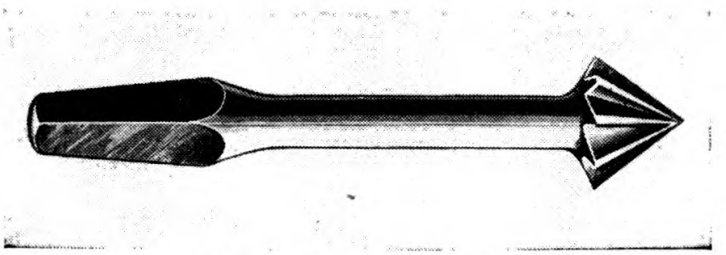

FIGURE 48.—Countersink.

(*c*) The screw driver bit (fig. 49), held in the brace, is generally used for driving heavy screws.

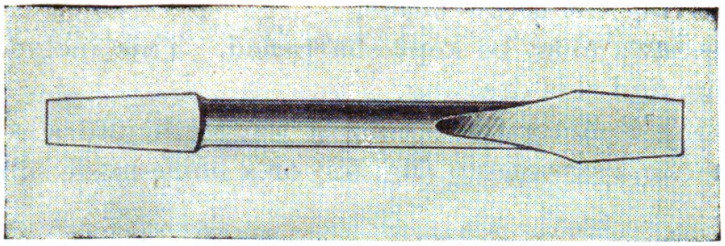

FIGURE 49.—Screw driver bit.

(*d*) To bore a hole smaller than $\frac{3}{16}$ inch, such as a small screw may require, use a twist drill (fig. 50), in the hand drill (fig. 45), or a drill bit in a brace. The same twist drills are used for wood as for metal, except that the points should be ground to an included angle of 60°

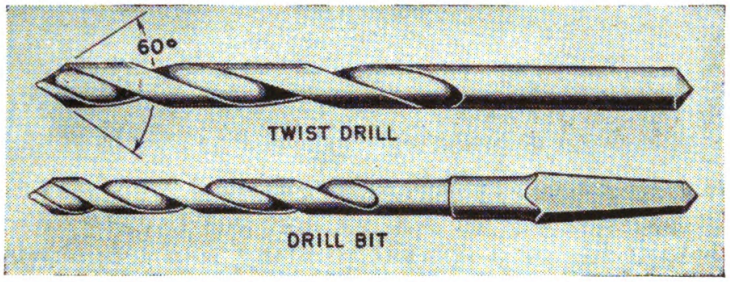

FIGURE 50.—Twist drill and drill bit.

instead of the usual 118° which is used for metal. Twist drills are completely described in TM 10–590.

k. Rasp and file.—The half-round cabinet rasp and file (fig. 51) are generally used for cutting away or smoothing wood or for finishing the rough edge left in a hole cut with the keyhole saw (fig. 27). Use

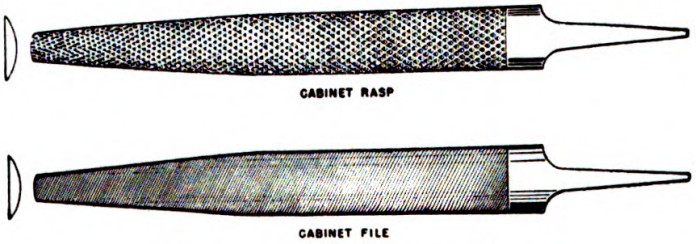

FIGURE 51.—Cabinet rasp and file.

the rasp first, and finish with the file. Select a 14-inch length for general work, or any size down to 6 inches for small work.

9. Care of hand tools.—*a. Lay-out tools, hammers, nail sets, and screw drivers.*—These require little attention, but wipe them with an oily rag occasionally to keep them from rusting, especially before putting them away for any length of time. Keep the points of divid-

ers and scribers sharp by honing. Grind worn screw driver points so that they will completely fill the slots in the screw heads. This prevents marring the screw heads.

b. Saws.—Saws must be kept sharpened. This includes jointing, setting, filing, and side dressing.

(1) Jointing is filing the points of the teeth into a straight line. Place the saw in a saw clamp (fig. 52) or a home-made substitute (fig.

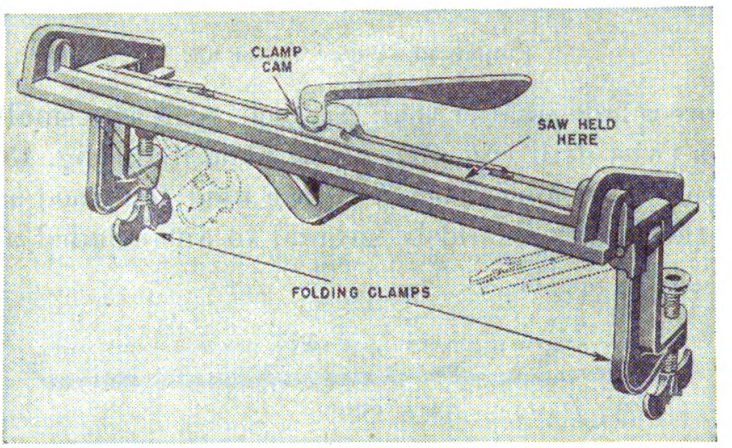

FIGURE 52.—Saw clamp.

53). Run a mill file or a special jointing tool lengthwise along the tops of the teeth to line them up, and then file them straight across to a uniform shape and size, filing back if the teeth are large, to bring them nearly to a point. The grooves at the bases of the teeth should be in a line parallel with the line of their points.

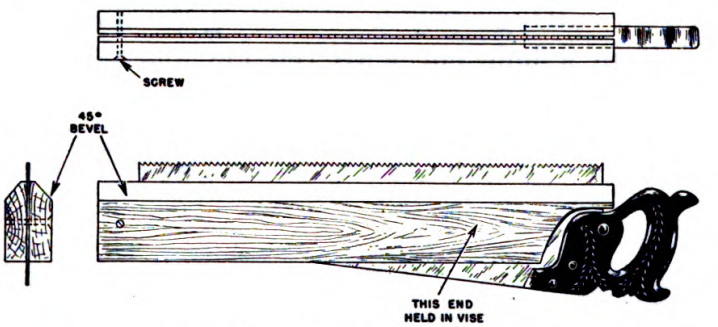

FIGURE 53.—Home-made saw clamp.

(2) Setting, the next step, is bending every tooth out about half the thickness of the blade so that the cut will be wide enough for the blade to clear it. This can be done with a light straight-peen hammer while the saw is laid on an anvil with the teeth projecting over the side. Beginning at either end, strike every other tooth; then turn the saw over and strike the teeth missed. This operation requires

skill and long practice. A saw well set with the hammer is better than a lever set saw, but the lever set (fig. 54) is easier to use and does a satisfactory job. Often a saw can be filed without setting, provided that the teeth are already in the proper position.

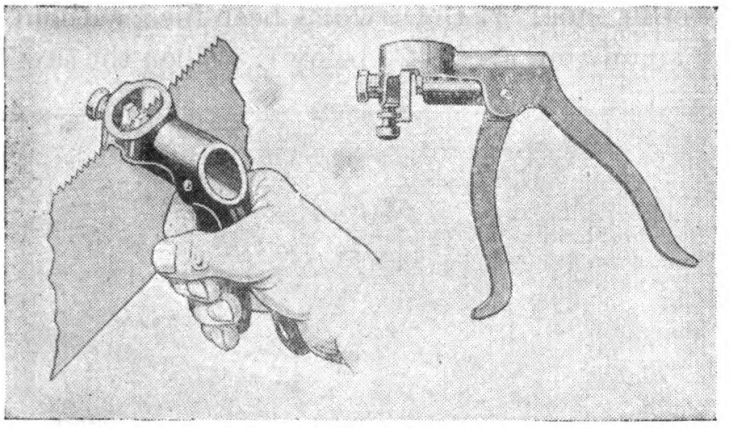

FIGURE 54.—Lever saw set.

(3) (*a*) Filing is done with the saw clamped as for jointing, except that the handle is placed to the left, and filing is started from this end. For *crosscut saws*, place a three-cornered file between two teeth, inclining it about 45° toward the smaller end of the saw (in this case, to the right). This forms the bevel, or fleam, on the teeth (see fig. 55).

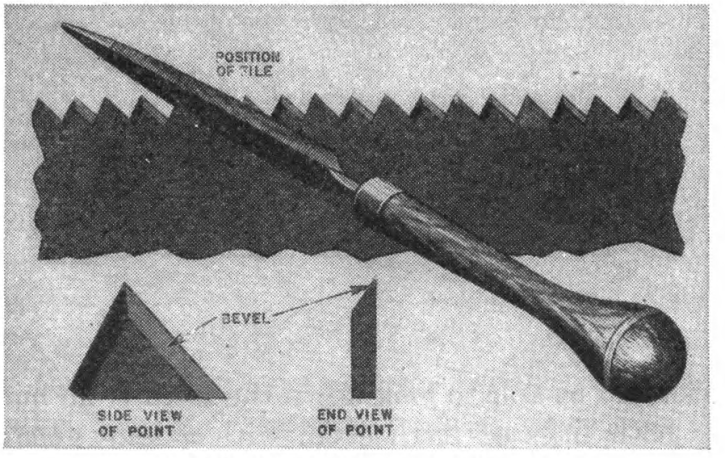

FIGURE 55.—Filing crosscut saw.

File both teeth at once. After working the whole length of the saw, turn it around so that the handle is to the right. Again inclining the file toward the tapered end, now to the left, work the length of the saw.

(*b*) File a ripsaw straight across the front of the teeth, lowering the file handle 2 to 3 inches, to bevel the tops of the teeth that were

set to lean away. Correctly filed ripsaw teeth should look like those in figures 29 and 30.

(4) Side dressing requires that the saw be laid on a board. If the saw has been set, run the flat side of the file gently along the side of the teeth to take off the roughness. Turn the saw over and do the same on the other side. If the saw has been filed without setting, side dress it with an oilstone (see *c*(2) below). When the saw has been side

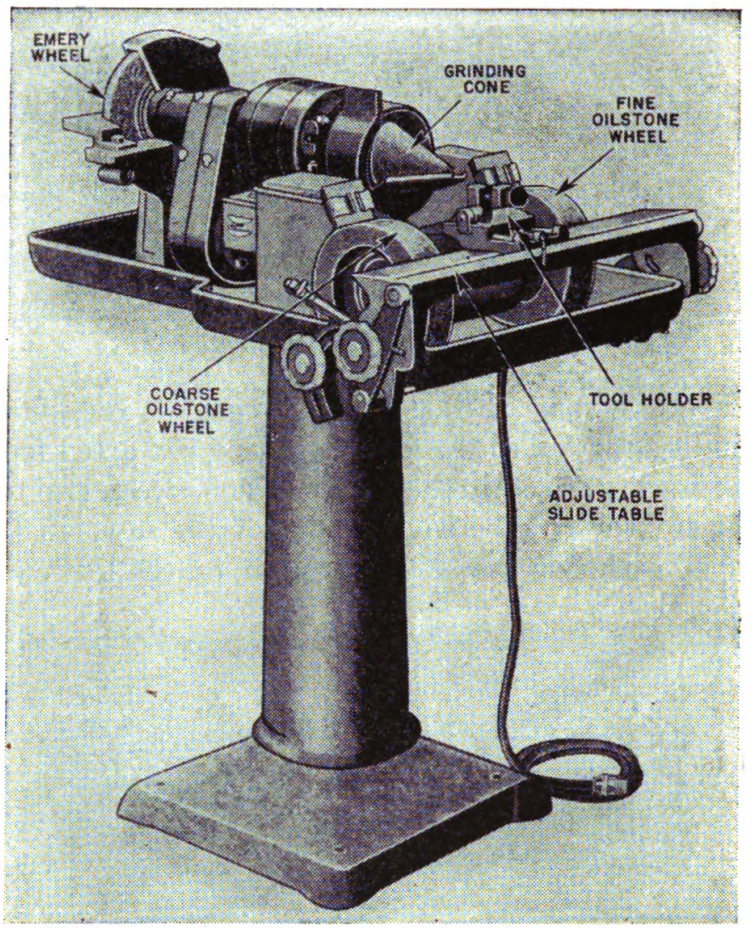

FIGURE 56.—Oilstone tool grinder.

dressed, one should be able to look down the teeth from butt to tapered end, and see both lines of teeth even, with a long groove down the center.

(5) Saw sharpening is an art. Only if the saw is in fair condition can an inexperienced person safely sharpen it. File lightly and carefully, following the old tooth shape. If the teeth have become irregular in shape and size, give the saw to an expert for filing.

c. Chisels and plane irons.—It cannot be said too often that edged tools must be kept sharp to do good work; the experienced woodworker knows this and the beginner might as well learn it at the outset. The

cutting edge must be keen, free from nicks, and properly beveled. This is accomplished by grinding and honing.

(1) *Grinding.*—(*a*) First, place the tool on the revolving wheel of a tool grinder to correct and hollow the bevel (see (2) below), and to grind out any nicks that may be in the cutting edge. When using a high speed abrasive wheel, be very careful to hold the tool lightly in contact with the wheel for a short time only, to prevent overheating the tool and spoiling its temper. Dip the tool in water frequently. Old-fashioned grindstones that revolve slowly by hand or foot power and pass through water are safer, but they are used very little today because they cut slowly. A very practical tool grinder for the woodworking shop, which has fine and coarse wheels and a conical grinder for internally ground gouges, is shown in figure 56. On this machine, the wheels are kept wet with oil.

(*b*) Chisels are ground to about the following bevels: paring, 15°; firmer, 20°; framing, 25°. Plane irons are always ground with a 30°

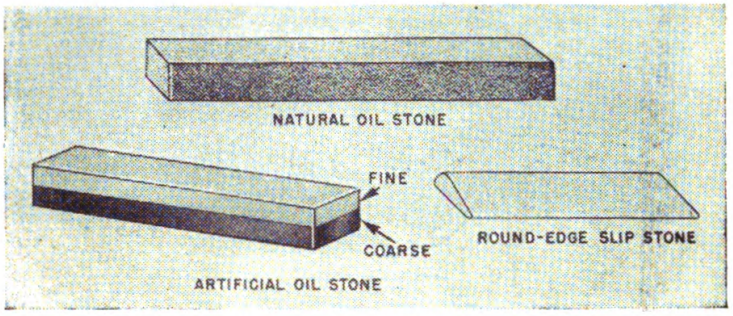

FIGURE 57.—Oilstones.

bevel; that is, the length of the bevel is twice the thickness of the iron. Remember that jack plane irons are slightly rounded at the cutting edge and other plane irons are ground straight across with slightly rounded corners (see fig. 36).

(2) *Honing.*—(*a*) Use an oilstone after grinding, to remove the "wire edge," a feathery fragment left on the tool edge after grinding, and to make the tool edge keen enough to cut wood smoothly. This process is called honing. The oilstone is so called because oil is used on it as water is used on a grindstone—that is, to carry off frictional heat between the stone and tool and to wash away the particles of stone and steel that are worn off by rubbing.

(*b*) Fast-cutting artificial stones, such as silicon carbide, are very good for general use; they may be had with a coarse side and a fine side. For a very keen edge, hone the tool afterward on a natural stone such as lily white Washita, and finally strop it on leather. Flat oilstones are used for chisels and plane irons; round edge "slip" stones are used for inside ground gouges. (See fig. 57.)

(*c*) When honing chisels and plane irons, hold the tool at the bevel angle shown in figure 58 and rub it back and forth on the oilstone. After a few strokes, turn the tool over and stroke it a few times *perfectly flat* on the stone. Repeat this process until the wire edge disappears and the cutting edge is keen enough. Test it by carefully drawing your thumbnail along the edge; if it slides smoothly, the wire edge is gone and the tool is sharp. A chisel or plane bevel ground on a wheel is slightly hollow. Therefore, the bevel rests on the oilstone only at its heel and toe, as shown, exaggerated, in the insert in figure 58. This position speeds honing, because there is only a small amount of metal to remove. When after repeated honing the bevel grows flat, regrind the tool to a hollow bevel.

d. Auger bits.—(1) To sharpen the spur hold the bit in the left hand with the twist resting on the edge of the bench. Turn the bit

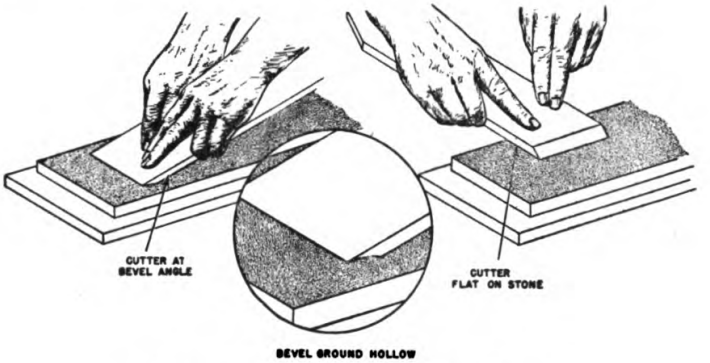

FIGURE 58.—Honing a plane iron.

around until the spur comes to the bottom. File the inside of it carefully, keeping the original bevel, until a fine bur shows on the outside. Remove this by brushing it lightly with a file. Never sharpen the outside of the spur.

(2) To sharpen the cutting lip, hold the bit in the left hand with the point on the bench, and file the top of the lip (the side away from the screw). Never file the bottom of the lip.

(3) A fine, half-round file is best for the lip and may also be used for the spur. It is rarely necessary or advisable to sharpen the screw, but it may be improved by carefully manipulating a small three-cornered file in the thread.

10. Machine tools for woodworking.—Machine tools for woodworking in the modern shop make some operations easier, quicker, and for any but skilled woodworkers, more accurate than hand methods. These include cut-off saws, table saws, band saws, jointers, planers, drill presses, shapers, turning lathes, and sanding machines, in addition to grinders (par. 9*c*).

a. Cut-off saw (fig. 59).—These are used mainly to cut long lumber down to the approximate length required. The universal cut-off saw may be set for miter, bevel, or rip sawing, as well as straight cut-off sawing, or it may be equipped with a dado head.

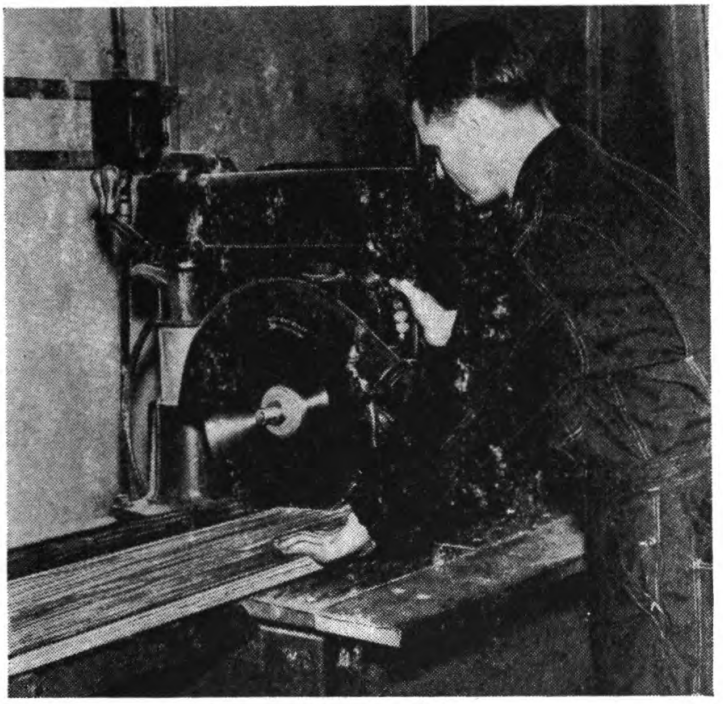

FIGURE 59.—Cut-off saw.

b. Table saw (fig. 60).—(1) The table saw is used mainly for ripping. A motor-driven circular saw is adjusted by a handwheel to project through a slot in a flat cast iron table a little farther than the thickness of the board to be sawed. Set the guide or "fence," according to the width of the board, and feed the wood into the saw, holding it against the guide. For accurate work, the board edge that is guided against the fence should first be trued in the jointer.

(2) Most table saws have gages, adjustable up to 45°, that slide in grooves for miter sawing. Many table saws have tilting tables or tilting saw arbors for bevel sawing, adjustable up to 45°. The machine shown in figure 60 accommodates two saws, either of which may be raised into position by a handwheel. By putting a "dado head" or groover (fig. 61) on the arbor in place of the saw, grooves of various widths and depths can be cut.

(3) Ordinarily, table saws are sharpened only in very large shops; usually, they are sent to a professional saw filer when they become dull.

c. Band saw (fig. 62).—(1) The band saw is required for sawing curves and convenient for most other sawing where lines have to

be followed. It consists of a long, thin, endless saw, running on two rubber-tired pulley wheels. For ordinary work, use a ⅝- or ¾-inch saw; a narrower blade will break easily. For curves of small radius, select a ¼- or ⅛-inch saw; a wider one will be twisted.

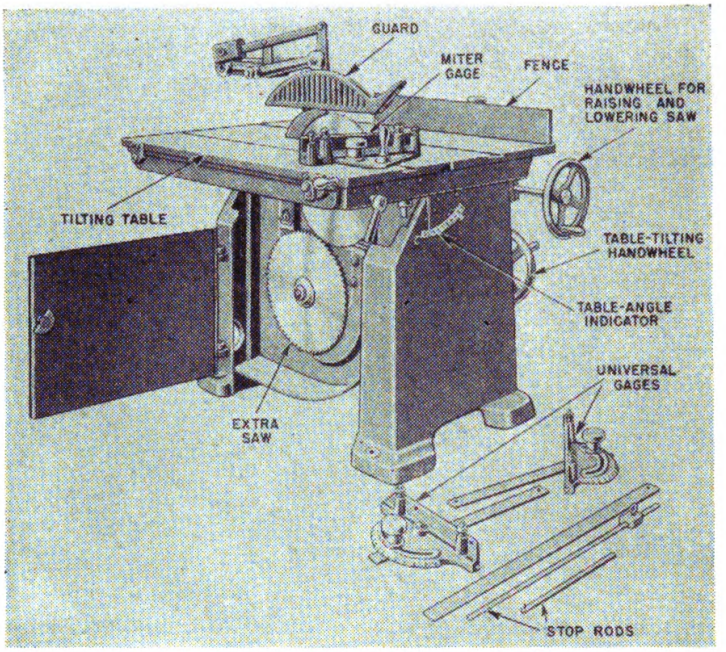

FIGURE 60.—Table saw.

(2) When replacing a band saw, move the saw guide away from the saw, put the saw on the wheels, tighten the tension just enough

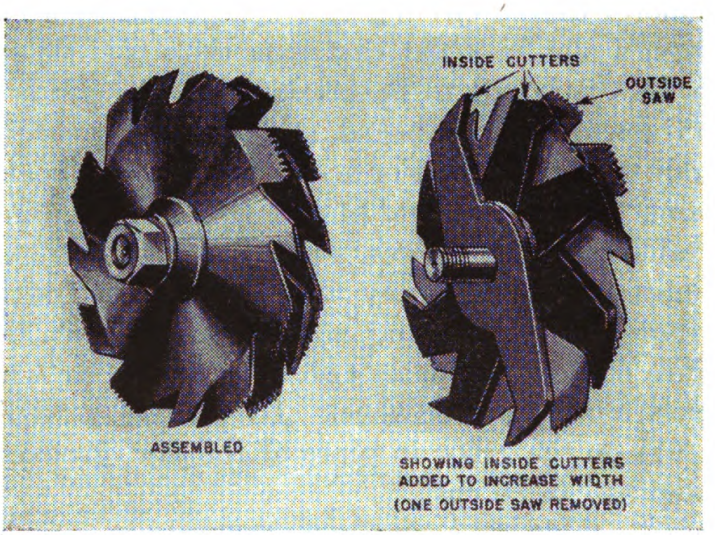

FIGURE 61.—Dado head or groover.

to keep the saw from swaying and rattling in the guides, and turn the wheels a few revolutions by hand until the saw "tracks" on the

wheel tires. Bring the friction guides forward nearly to the tooth gullets, and adjust them sidewise tight enough so that the saw will run between them without heating or sparking. Then adjust the guide wheel so that it almost touches the back of the saw.

(3) Ordinarily, use a band saw freehand, guiding the work with the fingers. Fences are furnished with the machine for ripping, and gages for miter sawing. The ripping fence is shown in place in the illustration. The table shown in figure 62 may be tilted for bevel sawing.

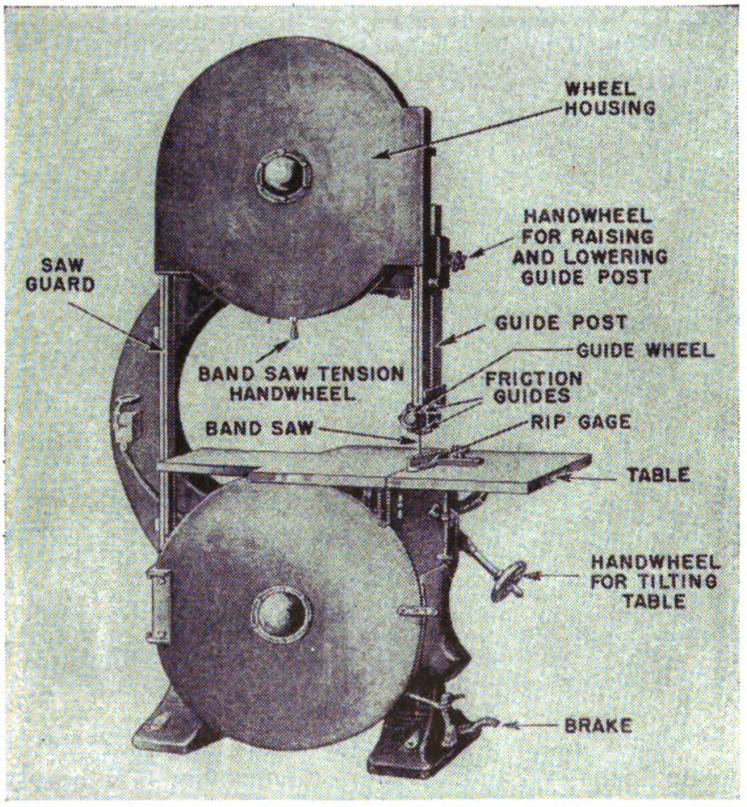

FIGURE 62.—Band saw.

(4) Band resaws also are often used in woodworking shops. These are similar to ordinary band saws, except that vertical power-driven rollers in front automatically feed the lumber to the saw. Band resaws are used mainly for sawing a thick board into thinner ones when the cut needed is too deep for a circular ripsaw; for example, to cut a 6- by 3-inch board into three 6- by ⅞-inch boards. A saw wider than an ordinary band saw is needed to insure a true cut in this work. When stopping work for the night, release the tension on the band saw or band resaw so that the wheels will not develop a wobble and make the saw run untrue.

(5) Only the largest shops have the equipment and experienced operator for sharpening band saws; they are usually sent to a professional saw filer.

d. Jointer (fig. 63).—The jointer is used for the same purpose as the hand jointer (plane) described in paragraph 8*h*, that is, to straighten, or true, surfaces and edges. It is more accurate than the hand jointer because the table of the machine is longer than the bottom of the plane. To use this machine, one must hold the work against the fence so that the surface to be cut is resting on the infeed table. As the work is fed into the cutter, the guard will move over far enough to allow clearance. One can adjust the depth of the cut by turning a handwheel, or can make a bevel up to 45° by tilting the fence.

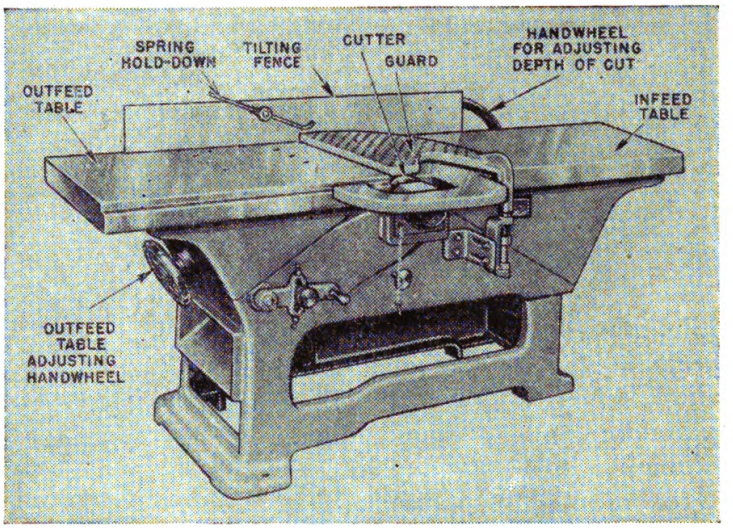

FIGURE 63.—Jointer.

e. Planer (fig. 64).—(1) The planer removes saw marks from the sides of rough lumber and reduces boards to required thickness. *It will not straighten the sides of a board, but will make them parallel.* To straighten a board, one face of it must first be trued in the jointer. The planer is used for the faces or sides of boards, never for edges unless they are wide—say, 3 inches. To operate it, feed the wood between the roller and the table, which is adjusted for the thickness of the board by a handwheel. The cutter is located in back of the roller. Do not expect the planer to remove too much stock in one bite; ⅛ inch in hardwood is about the maximum, and less is safer. Be sure that boards to be planed contain no nails.

(2) Planers and jointers usually have small motor grinding attachments that enable one to sharpen the blades when they become dull or nicked without removing them from the machine.

f. Shaper (fig. 65).—The shaper is simply a high-speed motor-driven, vertical spindle, projecting above a table. One of a variety

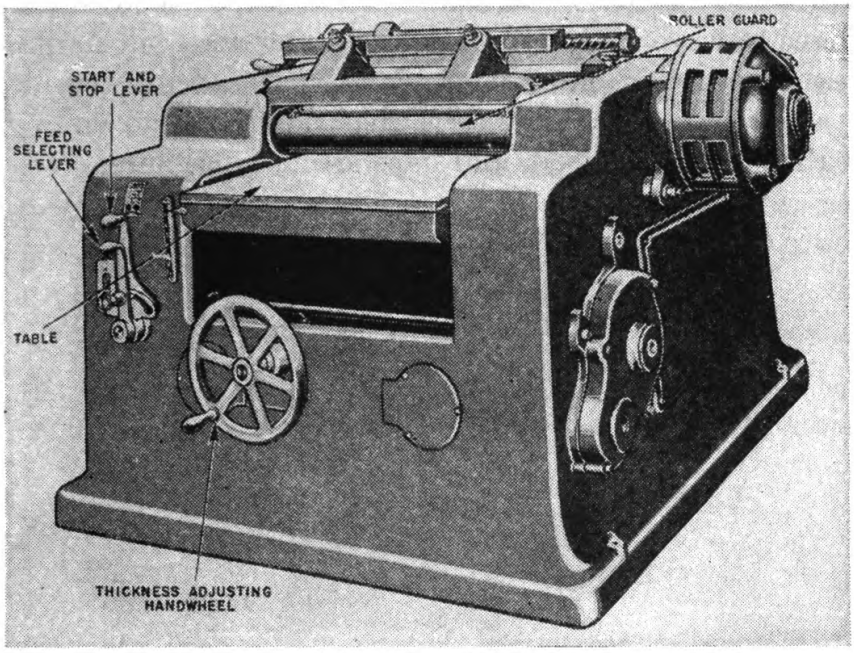

FIGURE 64.—Planer.

of cutters, each containing several blades, is held on the top of the spindle for cutting grooves and moldings. Feed work past the

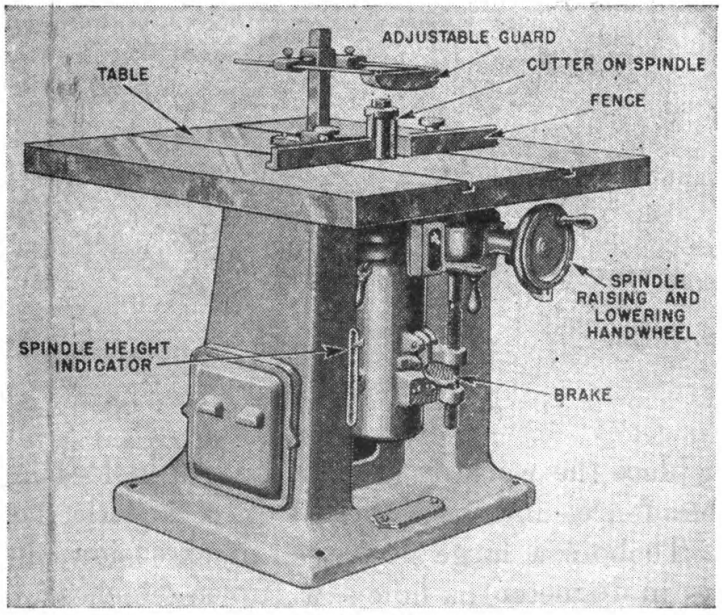

FIGURE 65.—Shaper.

cutter by hand and guide it against the adjustable fence. Spring hold-downs can be used to press the work against the fence and cutter.

Lowering the adjustable guard to the top of the work will prevent the fingers from being cut off by the spinning cutter blades.

g. Drill press or borer (fig. 66).—(1) Every woodworking shop should have some sort of drill press or boring machine similar to the drill press used in a machine shop. It uses twist drills and bit, which are like auger bits (par. 8*j*) except that they have no screw threads to draw them into the wood, and depend upon pressure. To operate

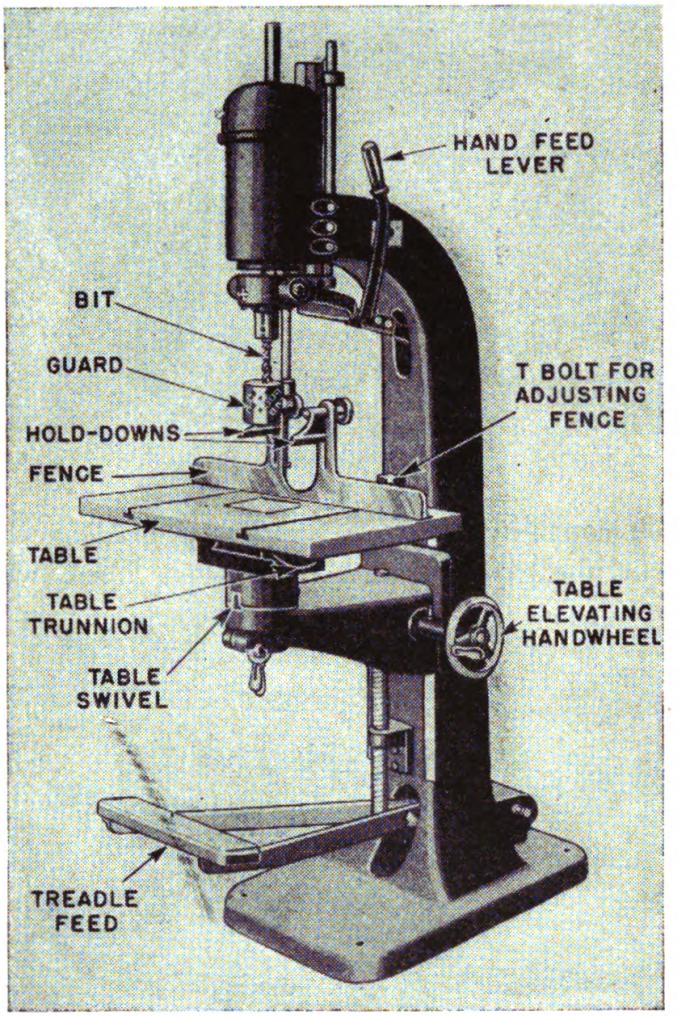

FIGURE 66.—Drill press.

a drill press, place the work on the machine table, locating it against the adjustable fence, and feed the bit into it with the treadle or hand lever. To bore a large hole, use an extension bit (for holes up to 3 inches in diameter), a hole saw (up to 4 inches), or a tubular bit (from 2 to 4 inches).

(2) One can mortise (fig. 69) with this machine, using an attachment that consists of a bit rotating inside of a square, hollow chisel. The bit bores a round hole in the wood and is followed by the chisel

which squares the hole to form the sides and corners of the mortise. Similar machines designed exclusively for mortising are called mortisers.

h. Universal woodworking machines.—Universal woodworking machines, often driven by a single motor, combine several machines in one, for example, ripsaw, band saw, jointer, planer, shaper, borer, and mortiser.

i. Sanding machines.—Sanding machines finish wood more smoothly than a planer or jointer by using replaceable sandpaper, or garnet paper disks, drum coverings, or belts. Sanding is usually done before applying a varnish or enamel finish.

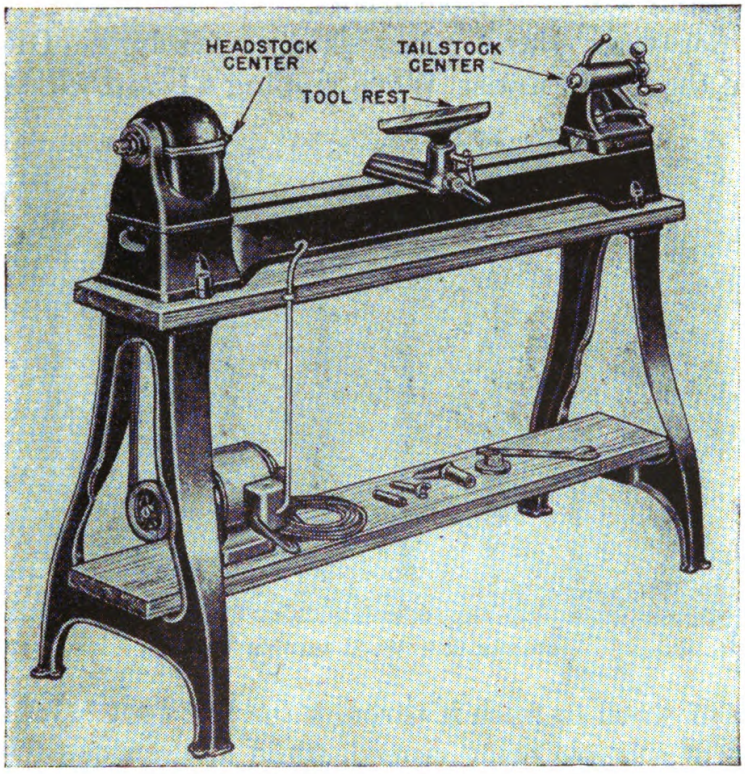

FIGURE 67.—Wood turning lathe.

j. Wood turning lathes (fig. 67).—Wood turning lathes are used for shaping round work. The work is rotated rapidly between the headstock and tailstock centers on the lathe. With a turning tool supported on the tool rest, the rotating wood can then be shaped. The turning tools (fig. 68) are similar to ordinary chisels and gouges, and are sharpened in the same way, but lathe tools are somewhat longer. Several types of automatic lathes are used in production shops. A metal working lathe can be used for wood turning, if it can be run fast enough. Special pulleys can be bought from the manufacturers for making the conversion, or they can be made up

in the shop. The same applies to centers and tool rests for wood turning.

k. Safety precautions.—(1) Cover all exposed belts, gears, chains, and other power transmission devices, saws, cutters, or other dangerous moving parts, with guards or housings so that one will be less likely to get caught in them. But even this is not enough. Avoid loose or flappy sleeves or other clothing that might be caught by moving parts. Above all, be careful and alert to keep the hands and clothing out of danger.

(2) Before starting a machine, make sure that all fast rotating wheels, saws, cutters, etc., are tight on their arbors, and remove keys from chucks and wrenches from arbors.

(3) Do not wear gloves when using a machine. Gloved hands have caused the loss of arms. When ripping a board full length, use a

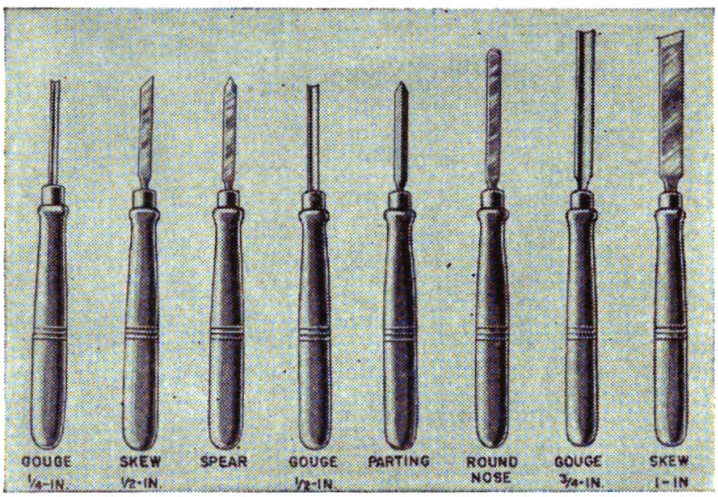

FIGURE 68.—Wood turning tools.

small piece of wood to push it through the last foot. When supporting the end of a board being ripped, stand at the side of it and avoid a punch in the stomach. Keep the floor clear around machines to avoid tripping or stepping on a bolt that will roll under the foot. Keep feed table on machine clear of all material except piece being cut. Keep belts free of loose ends of lacing or strings from frayed edges. Learn to be definite and methodical in all machine work; think before acting; keep mind and eyes on the cutting tool and fingers away from it. Jostling and other "horse-play" must be strictly prohibited in the shop. Do not attempt to talk to a workman who is using a cutting machine, nor permit anyone to distract attention when using one. If conversation is necessary first remove the work and stop the machine. Always stop a machine before leaving it.

11. Types of joints.—Some common types of joints, with their names, are shown in figure 69. Most joints in wood are screwed, nailed, or glued; often they are both screwed and glued.

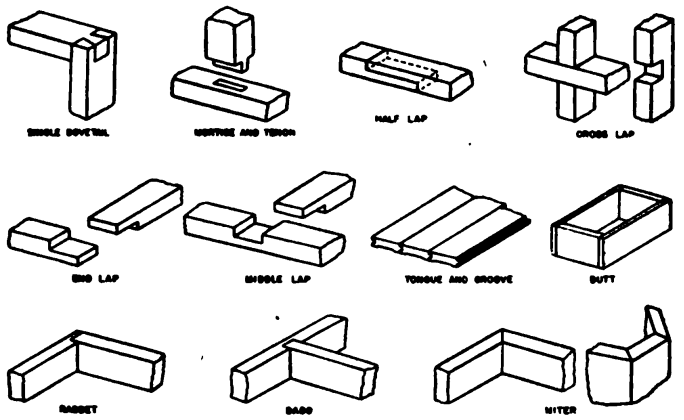

FIGURE 69.—Common types of joints.

a. Doweled joints.—Dowels are often used for making certain glued joints, particularly in furniture. Dowels are round wooden rods, usually of birch, which may be made in the shop or purchased in

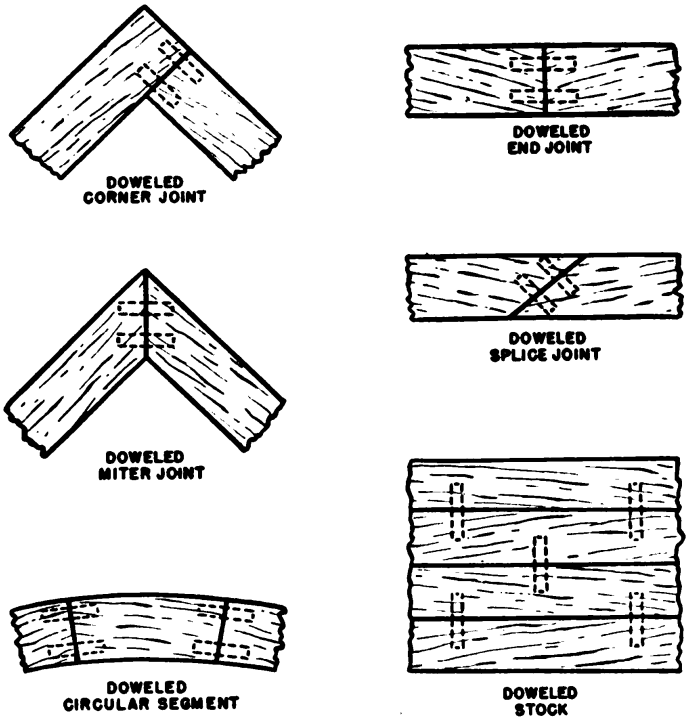

FIGURE 70.—Doweled joints.

sizes to fit auger bit holes. Figure 70 shows several types of doweled joints. Obviously, for successful doweled joints, the dowel holes in the pieces to be joined must be alined exactly opposite each other.

For this purpose use doweling jigs, which are metal patterns with guide holes. Put glue both in the hole and on the dowel so that the glue will not be wiped off the dowel when inserting it in the hole.

b. Splice and scarf joints.—Important structural members require splice or scarf joints suitable to withstand tension, compression, or bending.

(1) Splice joints (fig. 71) consist of two pieces of wood placed end to end with cover pieces, or fishplates, bolted or nailed on each side. Those shown at the top of the figure are designed to resist compression and those at the bottom are designed to resist tension.

(2) A scarf joint is an endwise lap joint made by beveling, notching, or otherwise cutting away two pieces to form one continuous piece when nailed, screwed, bolted, or glued together. Often they are both screwed and glued. Sometimes fishplates are used. Some scarf joints

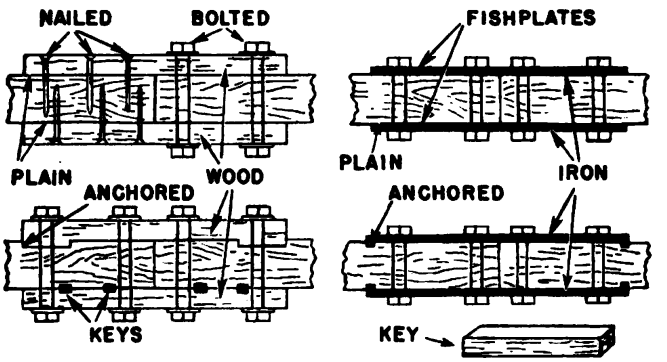

FIGURE 71.—Splice joints.

designed to withstand compression, tension, and bending are shown in figure 72. Of those shown, the joints with iron fishplates are the stronger in each group. The second bending scarf joint illustrated is obviously unsatisfactory, because it separates at the square end where a miter is required. The first bending joint is suitable for members encountered in bodywork, where the principal objective is rigidity. It is not suitable for heavy timber construction, where the available bending strength of the member must be developed in the joint.

12. Gluing.—Glue may be either hot or cold.

a. Hot glue.—Hot glue, an animal product, is purchased in dry flakes or sheets, which must be soaked in water, then heated in a glue pot which is similar to a double boiler. Its main advantage is that it sets quickly; in fact, so quickly that one must work fast to complete the joint before the glue sets.

b. Cold glue.—There are numerous kinds of cold glue. One of the best is casein glue which is manufactured from skimmed milk. It

comes as a powder, which must be freshly mixed with water for each job, as the mixture will lose its valuable adhesive properties if stored. Cold glue is just as strong as hot glue, and casein glue resists moisture more effectively, but it needs considerable time to set. Avoid any movement or strain in the joint until the glue has set; it is best to use clamps.

13. Wood bending.—Wood bending is sometimes done in the woodworking shop by "steaming" or soaking the wood with hot water

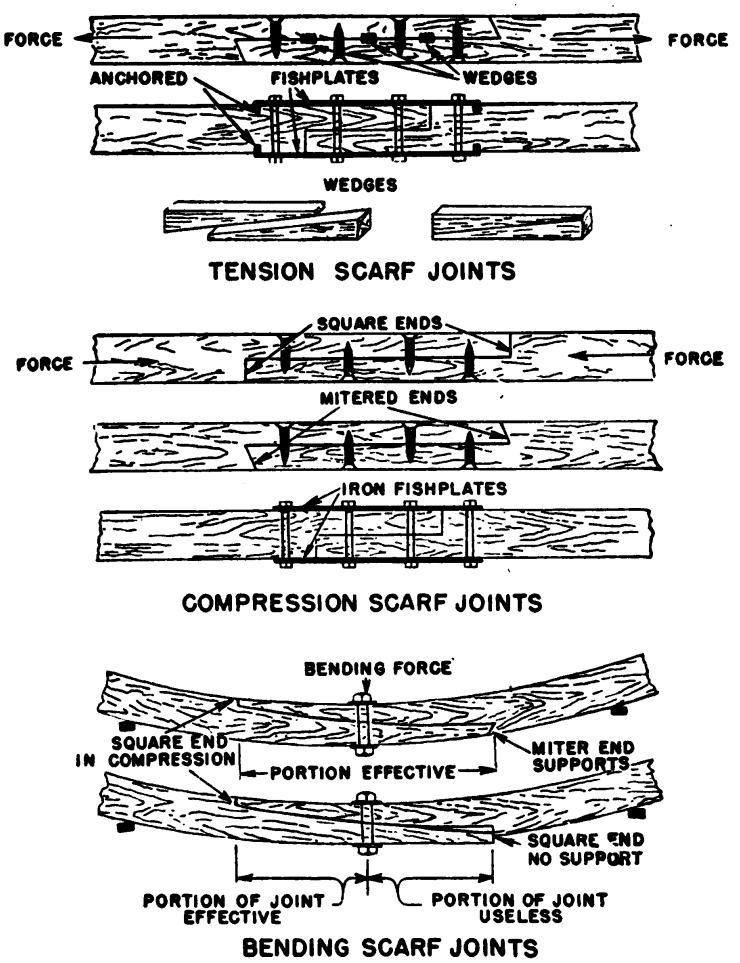

FIGURE 72.—Scarf joints.

to soften it, and then placing it in a form. When it dries it permanently retains the approximate shape of the form.

14. Pattern making.—*a.* Pattern making is a specialized and skilled form of the woodworker's art often performed in fourth echelon shops. A pattern is a wooden form in the shape of a desired metallic casting. It is used in foundries to impress its shape in a sand mold into which molten metal is later poured. A "shrink rule," selected according to the metal to be cast, is used for laying out

dimensions on patterns. The inches and fractions on a shrink rule are slightly longer than on the standard rule, because the metal in the mold, which is the same size as the pattern, shrinks slightly in cooling. Therefore, if the dimensions of the pattern are laid out with the shrink rule, the finished casting will have the correct dimensions after shrinkage.

b. Sides of patterns are tapered slightly for "draft"; that is, to permit them to be withdrawn from the sand mold without breaking or crumbling it. Patterns are usually made in two or more separable parts fitted together by dowel pins.

c. These are a few of the fundamentals of pattern making. It is an extensive subject in itself, a full discussion of which is beyond the scope of this manual.

15. Woodworking in automotive repair shop.—The variety of jobs that woodworkers are called upon to do is so great that no one can anticipate all that may confront them. Few wooden parts are used in the latest Army motor vehicles—as a rule, only the sills, troop seats, and bows for the paulins. But one may have to replace wooden body parts on older vehicles, repair the wooden bodies of special-purpose vehicles, both old and new, or construct wooden-frame upholstered seats to replace damaged steel-frame seats. One may even have to construct bins, benches, saw horses, tables, or other woodwork for the shop or for other shops on the post. With a job like one of these to do, success or failure will depend not on specific instructions, but on an understanding of the purpose and limitations of every tool in the shop, operating them skillfully and *using one's head* to study the problem before starting to work. Remember that it is always better to replace a wooden body member than to patch or splice it. Probably drawings or designs, or a similar member to use as a model will be furnished but it may be necessary to design the new member. Experience and ingenuity plus a thorough knowledge of tools and jointing should "see one through" the most difficult assignment.

SECTION III

UPHOLSTERER

16. General.—The work of the upholsterer in the Army includes repairing and replacing the following parts of Army motor vehicles: seats and back cushions, tops and paulins, curtains and lights (celluloid

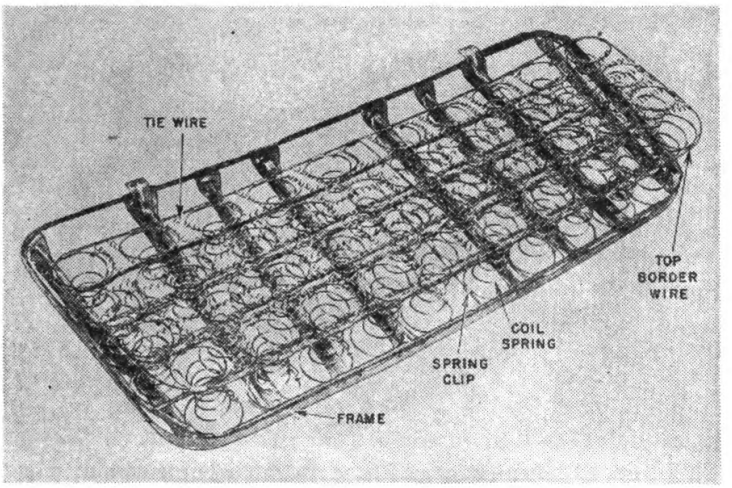

FIGURE 73.—Steel frame-and-springs assembly.

or glass in curtains), roll-up straps, safety straps, carpets and rubber mattings, door and cowl panels, and miscellaneous interior trim.

a. Wood frames.—Wood frames were formerly used in seats and back cushions to hold springs tied together with twine and often supported by webbing. Curled horsehair, moss, and excelsior were used for padding, which was usually tufted.

b. Steel frame-and-spring assemblies.—Steel frame-and-spring assemblies having springs tied together with wire (fig. 73) have largely replaced wooden frames. Cotton batting or foam rubber (latex) or a combination of the two are used for padding. Tufting is seldom used.

17. Materials used.—*a. Wood.*—Damaged seat and back frames, even steel ones, may be replaced with hardwood, such as oak, ash, or

hickory. Plywood is ordinarily used for supporting full depth foam-rubber cushions on the frame.

b. Burlap.—Burlap is ordinarily used for covering spring assemblies.

c. Insulating pads.—An insulating pad is placed on top of the wire springs to keep them from cutting into the padding. Jute batting is a good material for this purpose, although two or more thicknesses of burlap are sometimes used.

d. Cotton batting.—Cotton batting is most commonly used today as a padding material over the springs and insulating pad.

e. Twill.—Twill or similar material is generally used to cover cotton batting and keep it from shifting. An outside covering is applied over the twill.

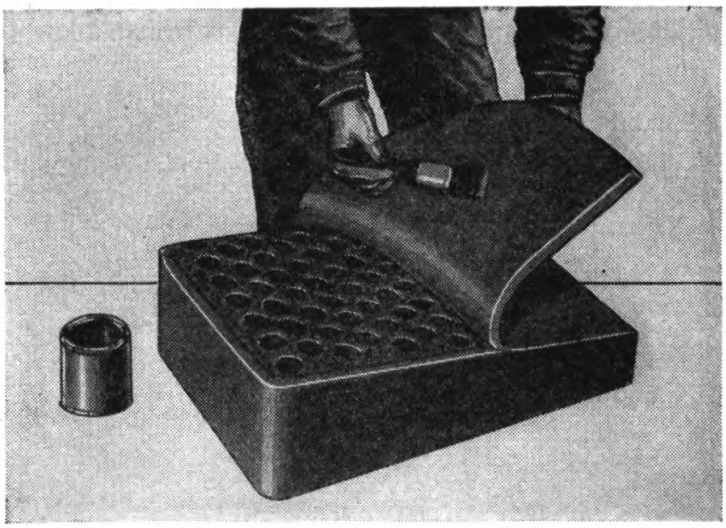

FIGURE 74.—Fabricating a foam-rubber cushion.

f. Foam rubber.—Foam rubber, or foamed latex as it is sometimes called, has recently come into use for padding motor vehicle seats and back rests, and will probably be used more and more. It is available in molded cushions of the size and shape to be used, or in blocks and flat stock that can be cut and cemented to the desired size and shape (see fig. 74). Tacking tape can be cemented to the bottom of the cushion and tacked to the frame (see fig. 75). Foam rubber is available in several degrees of density, which determine its softness, for different purposes. For example, a softer grade may be used for back cushions than for seats.

g. Coverings.—Seats and backs of passenger vehicles can be covered with almost any upholstering fabric, such as mohair or whipcord. Army trucks, command cars, and the like are upholstered with one of the following materials:

(1) Fire-, water-, and weather-resistant No. 8 olive-drab cotton duck, a general-purpose material which probably will be widely used.

(2) Artificial leather, usually either pebble- or long-grained, generally used for truck seats and backs up to the present time.

(3) Genuine leather, used for command cars and for fire engines and crash trucks.

h. Twine and thread.—Heavy twine is sometimes required for tying springs together and for making welt seams in leather. Flax twine is used mainly for sewing insulating pads to frame-and-spring assemblies. Formerly it was used extensively for tufting. Although

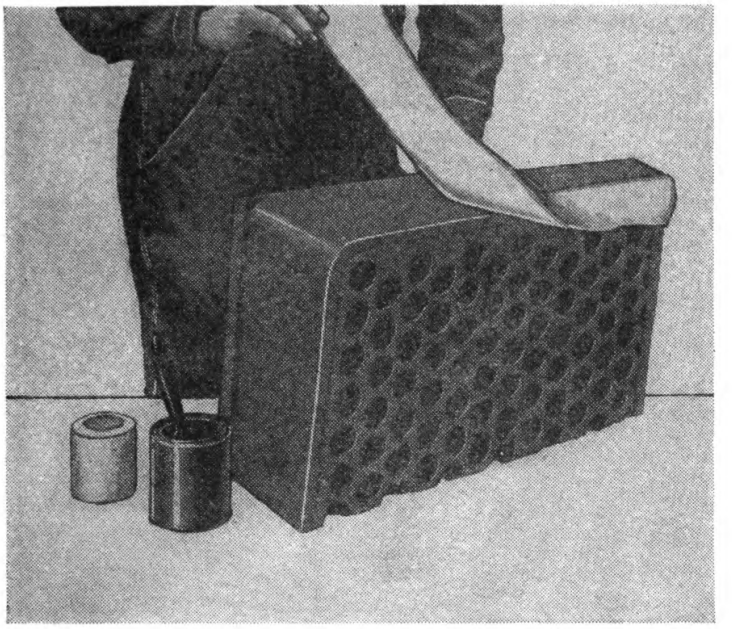

FIGURE 75.—Attaching tacking tape.

any kind of thread is suitable for hand stitching, No. 12, four-cord, left-twist, cotton thread, usually in black and olive drab, is used in the sewing machine for all seams, patching, and the like. Beeswax is generally used to wax thread for hand stitching. It keeps the thread from tangling, saves wear, and prevents it from pulling through the material.

i. Tacks.—Cut tacks in a variety of sizes (for example, 3-, 4-, 6-, 8-, 10-, 12-, and 14-ounce) are used for tacking upholstery to wood frames. An upholsterer should use sterilized cut tacks, because he customarily holds them in his mouth.

(1) No. 12 saddle tacks in olive drab and black are used for bindings.

(2) Either nails or double-pointed tacks are used for fastening spring assemblies to wooden frames.

j. Hog rings, C-clamps, and spring clips.—Hog rings, C-clamps, and spring clips are used extensively for fastening upholstery to the frame wires of steel spring assemblies.

(1) Hog rings are open rings of stiff steel wire which are hooked through the fabric and around the frame wire, and closed with a pair of special hog-ring pliers.

(2) C-clamps are small spring-steel strips bent in the shape of the letter C; the fabric is doubled over the lower edge of the cushion frame and the C-clamp pressed over it, usually with a pair of pliers.

(3) Spring clips, made of sheet steel, are sometimes required for attaching springs to wire frames. (See fig. 73.) They are closed with special spring-clip pliers.

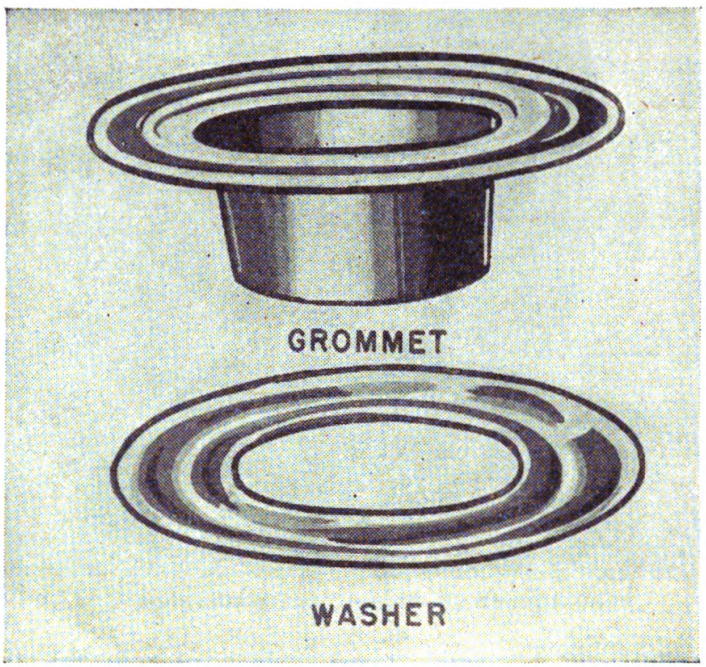

FIGURE 76.—Grommet.

k. Tubular rivets.—Tubular rivets are used for attaching leather cover reinforcements and roll-up strap buckles on tarpaulins and for fabricating safety straps. They are inserted by means of a pedal-operated machine. Copper rivets with burs used occasionally for leather work, are riveted with a ball-peen hammer.

l. Cotton duck.—Cotton duck, of the same grade described in *g* above, for seat covering, is used for patching tarpaulins and the front and rear curtains of Army trucks.

m. Grommets (fig. 76).—Ropes are attached to paulins and end curtains by means of No. 4 brass washer grommets.

n. Tops.—Rubberized duck is used for tops of command cars, and artificial leather or rubberized canvas for passenger cars.

o. Curtain materials.—The front and rear curtains of Army trucks have no lights in their windows, merely flaps to cover the openings. The edges of curtains and flaps are hemmed. Passenger car curtains are made from artificial leather or rubberized canvas, with celluloid lights sewed in by machine. The inner edges of the curtains, surrounding the light, are usually finished with a 7/8-inch gimp. The outer edges are usually bound with 1¼-inch bias tape.

p. Fasteners (fig. 77).—Fasteners of four types—lift-the-dot, common-sense, Burco, and durable-dot—are used. Burco or common-

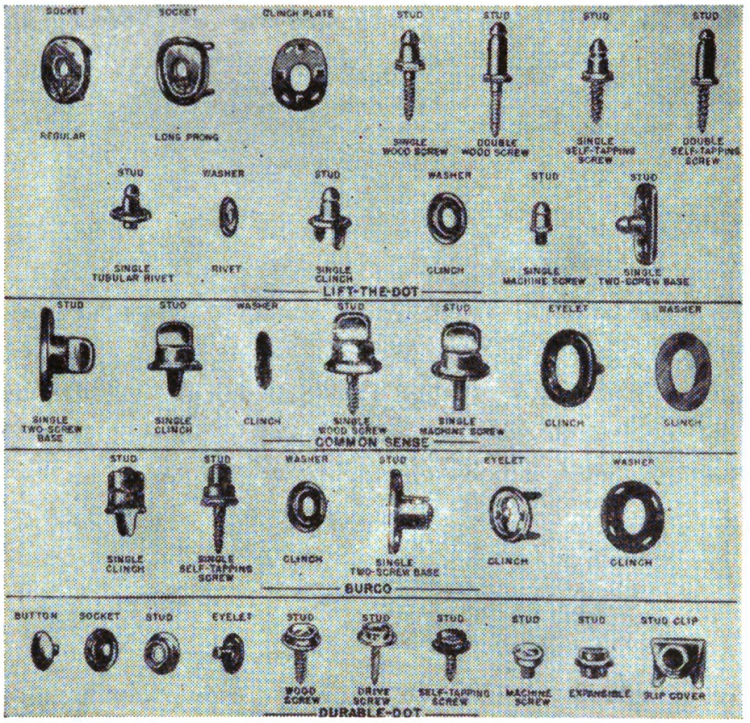

FIGURE 77.—Four types of fasteners.

sense fasteners are ordinarily used for fastening the flaps of Army truck front and rear windows, but any of the four types is satisfactory for fastening other kinds of curtains to car bodies and to tops and adjacent curtains. These fasteners, in brass, nickel, or chromium finish, are made for curtains of single or double thickness and may be attached in any of several different ways.

q. Webbing.—Several kinds of cotton webbing are used. Webbing for supporting springs of back cushions is used occasionally for replacement in old vehicles, although the newer ones have the springs supported on steel frames.

(1) Seven longitudinal strips of webbing are used in the top of each command car to keep it from sagging between bows.

(2) Webbing tape is sometimes used for binding canvas articles such as tool kit rolls.

(3) Safety straps are made from two thicknesses of special webbing, sewed together and fastened by tubular rivets at the ends near the brass catches (fig. 78).

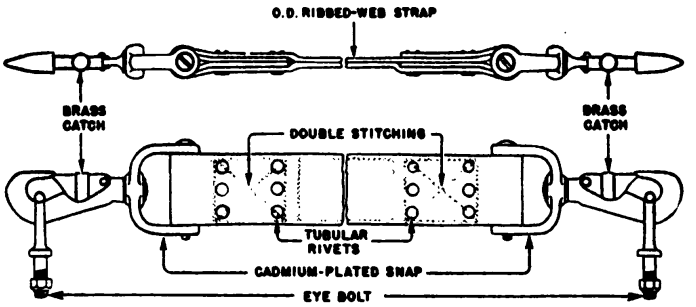

FIGURE 78.—Safety strap.

r. Rope.—Tarpaulins and end curtains as provided by the manufacturer often have tie, lacing, and draw ropes of cotton. When replacement is required, however, manila hemp rope is generally used.

s. Leather straps and buckles.—Leather straps and buckles are required occasionally for replacement of roll-up straps and buckles.

t. Black cardboard.—Black cardboard, either pebble or long-grained, is often used for door and cowl panels.

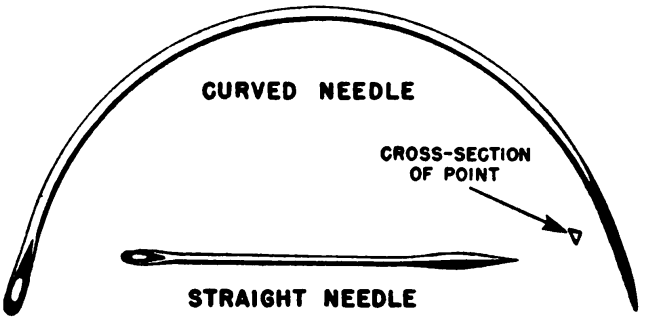

FIGURE 79.—Needles.

u. Carpet and rubber matting.—Carpet and rubber matting are sometimes required for replacing floor coverings.

v. Miscellaneous interior trim.—Materials for miscellaneous interior trim, such as headlinings, wind hose, windlace, and wireon molding, are required from time to time. (See fig. 110.) These are usually purchased from the manufacturer to match the trim of the particular vehicle to be refinished.

18. Hand tools.—*a. Needles* (fig. 79).—Two kinds of needles are generally used by the upholsterer: curved needles about 3 inches long

and straight needles about 2½ inches long. Tufting needles 6 to 19 inches long were once used extensively but seldom today. Needles have triangular or round points. Triangular points are better for general use as they will penetrate heavy material more easily. Curved needles are handy for such jobs as sewing insulating pads to spring frames; straight needles are used for all ordinary sewing.

b. Awl.—An awl is often used for making a hole before inserting the needle in material difficult to penetrate and for marking lines on cardboard; also for scoring celluloid with lines, along which the celluloid may be broken.

c. Palm and thimble (fig. 80).—A sailmaker's palm, which consists of a metal disk held in a strap around the hand, is generally used

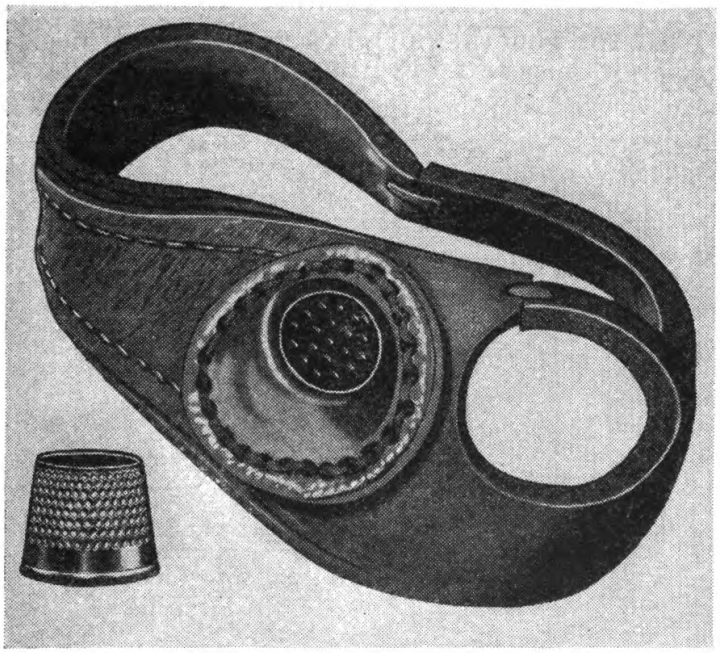

FIGURE 80.—Palm and thimble.

for pushing needles through heavy materials where considerable force is required. Open-end thimbles are sometimes used for lighter work.

d. Rule, steel square, and straightedge.—A 3-foot steel flexible rule, such as sheet metal workers use, is convenient for laying out straight lines and guiding straight cuts; a carpenter's steel square is suitable for right angles. Straightedges, usually of wood and in lengths up to 6 feet or more, are used for marking long, straight lines.

e. Chalk and crayon.—Chalk and crayon, usually yellow, are used for marking lines on upholstering materials.

f. Shears and knife.—Heavy shears are used for most cutting, although a bench knife (fig. 81) is often more convenient for trimming

and for working where shears will not reach. The knife must be kept sharp. This is usually done with abrasive cloth mounted on a wooden block or paddle.

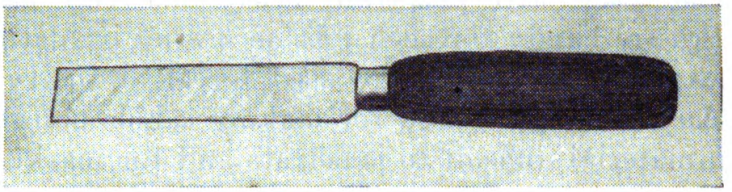

FIGURE 81.—Bench knife.

g. Hammers.—A typical trimmer's hammer is shown in figure 82. It is used mainly for driving and withdrawing tacks, for which it has a claw attached to the end of the handle. A ball-peen hammer (fig. 82) is often used for general purposes and the ball-peen is used for upsetting rivets.

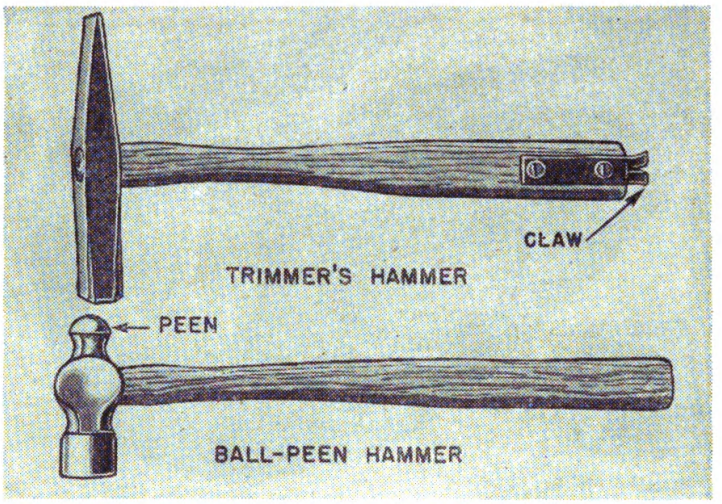

FIGURE 82.—Hammers.

h. Cold chisel.—The cold chisel, driven by means of a hammer, is commonly used for stripping off old upholstery.

i. Screw driver.—The screw driver is used for driving wood and metal screws. It is bad practice to use it for stripping.

j. Mallet.—A mallet either of wood or rawhide should be used for driving punches and the grommet-setting die. (See *m* below.)

k. Prick punch.—The prick punch has many uses, particularly making holes in body sheet metal for metal screws.

l. Fastener tools.—Fasteners can all be attached by hand punches and screw drivers, such as those shown in figure 83. Bench and pedal machines are used for production work.

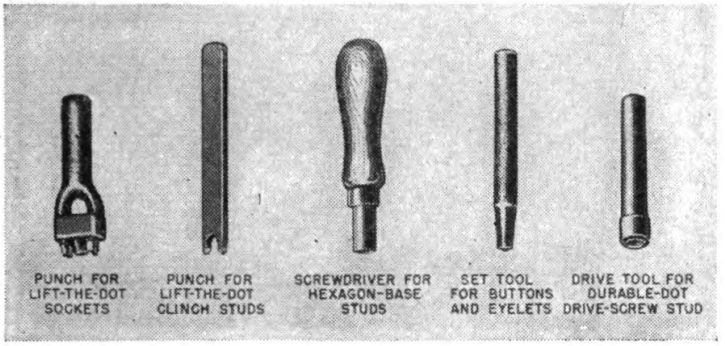

FIGURE 83.—Hand tools for attaching fasteners.

m. Hollow punch and grommet dies.—Holes for grommets are made in duck and canvas by means of the hollow punch. The punch should be used on the end grain of a hardwood block and driven by a wooden or rawhide mallet. Grommets are fastened in position by placing them between the dies (fig. 84) and striking the handle with a mallet (in preference to a hammer).

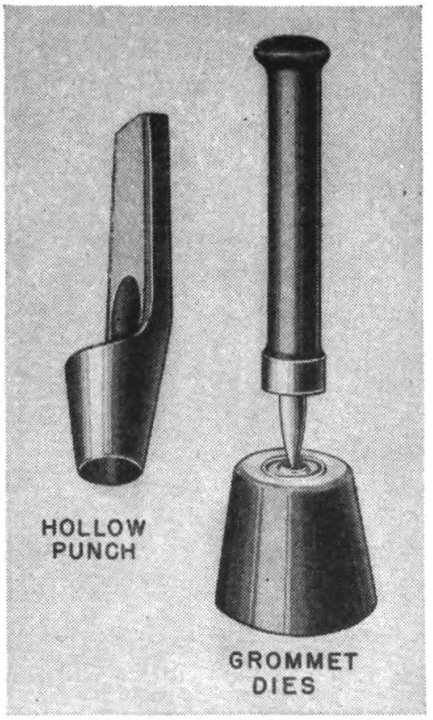

FIGURE 84.—Hollow punch and grommet dies.

n. Leather tools.—Leather tools are seldom required because straps are purchased ready-made, and upholstery and reinforcing leather can be handled like cloth. However, a revolving punch (fig. 85) is handy for making additional holes. It cuts clean holes of several different sizes and can be used for other materials as well as leather.

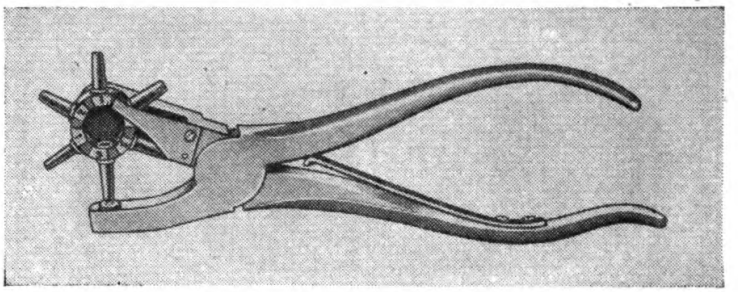

FIGURE 85.—Revolving punch.

19. Sewing machine.—The new sewing machine used by the Army (fig. 86) is a single-needle, lock-stitch machine with compound feed and high-lift alternating pressure designed especially for automobile upholstering, tarpaulins, and similar work. It has a high arm with a working space of 30 inches at the right of the needle. On the front of the machine is a handwheel which, when pressed in, turns the balance wheel, thereby making it unnecessary to reach for the balance wheel. An unwinder, on which two spools of thread are placed, is used with large machines. Instructions for using the machine are given in this manual. Instructions for adjustment and repair are given in the manufacturer's manual.

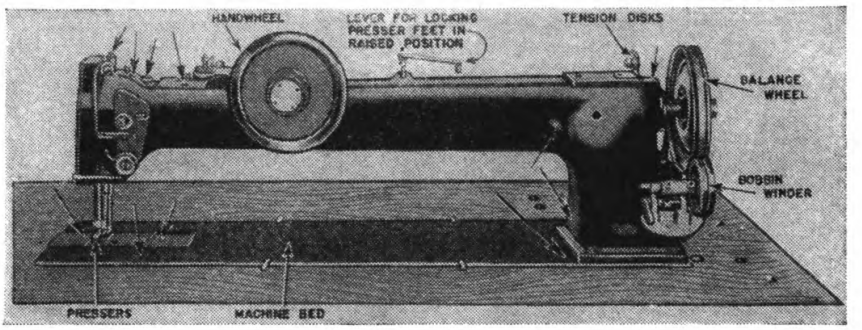

FIGURE 86.—Front view of machine showing oiling points.

a. Speed.—Speed is governed by a foot controller. The machine may be run as fast as the nature of the material will permit, up to 1,500 rpm, which is the maximum speed of the machine. A new machine should be run more slowly until the parts which are in movable contact have glazed each other. When the machine is operating, the balance wheel should turn over toward the operator.

b. Lubrication.—When the machine is received from the factory, clean and oil it thoroughly. If used continuously, it should be oiled at least twice a day at each of the places designated in figures 86 to 90, inclusive, by arrows without nomenclature.

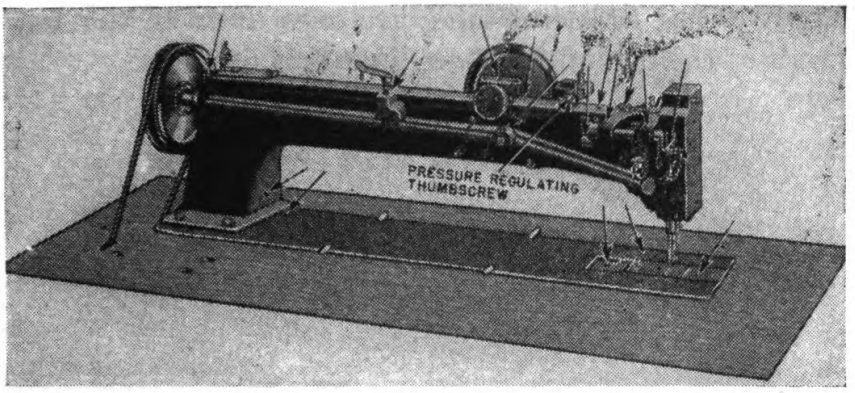

FIGURE 87.—Rear view of machine, showing oiling points.

(1) Loosen the thumbscrew in the upper end of the faceplate, turn it upward, and oil the wick and bearings which are thus uncovered (fig. 88), then turn down the faceplate and tighten the thumbscrew.

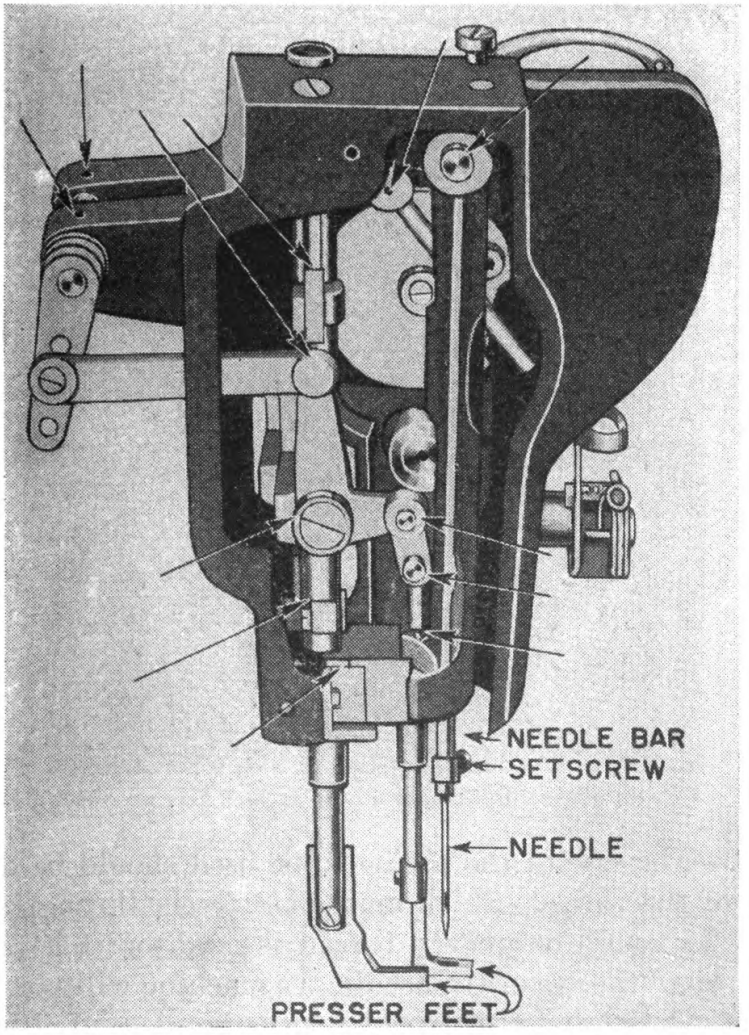

FIGURE 88.—End view of machine, with faceplate removed, showing oiling points.

(2) Apply a few drops of oil four times daily to the felt pad in the side wall of the bobbin case (see fig. 94).

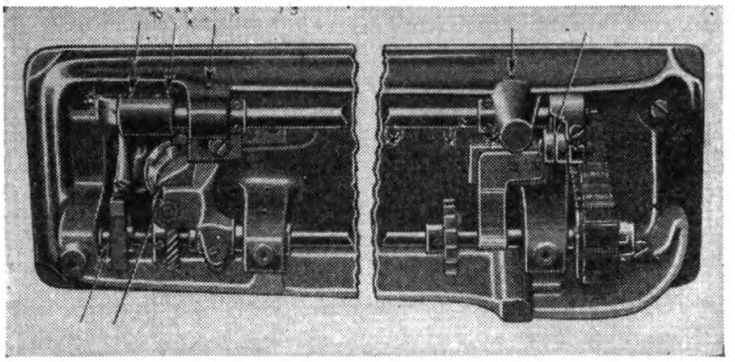

FIGURE 89.—Base of machine showing oiling points.

(3) Figure 90 shows the oiling points back of a handwheel on the long-arm machine. A handwheel is not necessary on a shorter-arm machine.

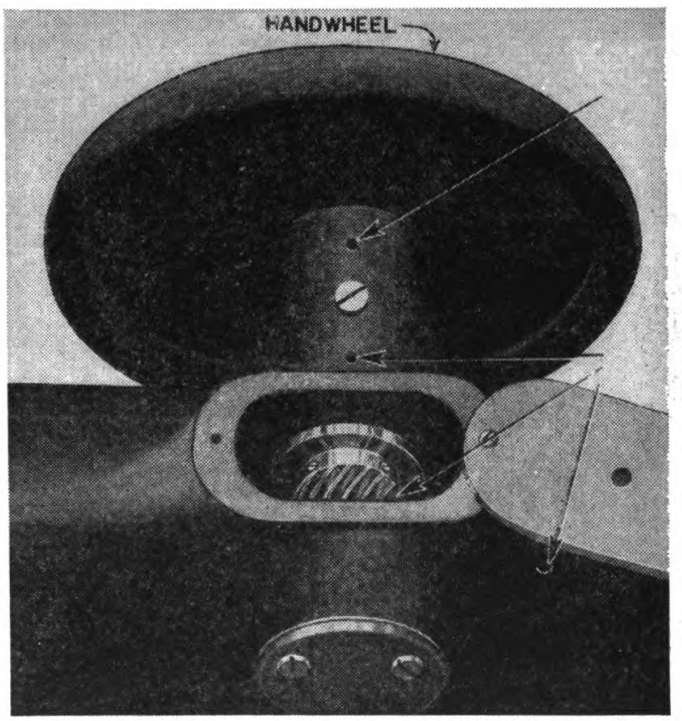

FIGURE 90.—Oiling points at top of long-arm machine.

c. Needle.—The size of the needle to be used should be determined by the size of the thread, which must pass freely through the eye of the needle. If rough or uneven thread is used, or if it passes with difficulty through the eye of the needle, the machine will not work well.

d. Thread.—Use left-twist thread for the needle and either left- or right-twist thread for the bobbin. To determine which kind of thread

is being used, hold it as shown in figure 91 and turn the thread over toward the body between the thumb and forefinger of the right hand. If it is left twist, the strands will wind tighter; if right twist, they will unwind.

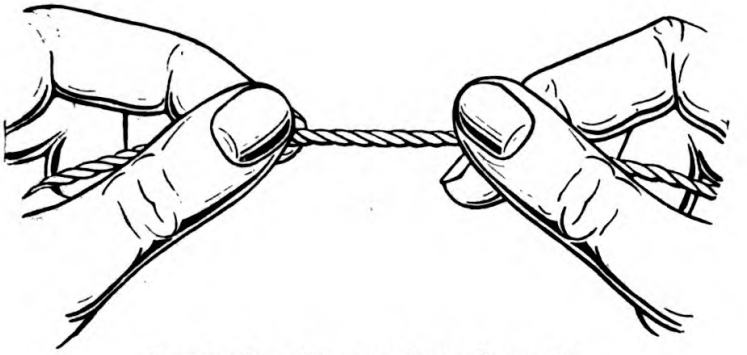

FIGURE 91.—How to determine twist.

e. To set needle.—Turn the balance wheel over toward the body by means of the handwheel (fig. 86) until the needle bar (fig. 88) moves up to its highest point; loosen the setscrew in the needle bar and put the needle up into the bar as far as it will go, with its long groove toward the left and its eye opening toward the ends of the machine; then tighten the setscrew.

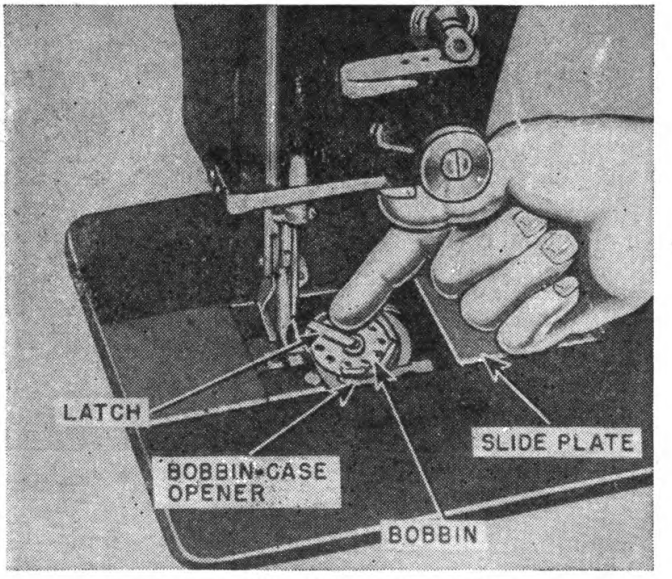

FIGURE 92.—Removing bobbin.

f. To remove bobbin (fig. 92).—To remove the bobbin, draw back the slide plate in the bed of the machine and turn the balance wheel until the bobbin case opener moves clear of the bobbin. With the forefinger or a screw driver, raise the latch to a vertical position and lift out the bobbin.

g. To wind bobbin (fig. 93).—To wind the bobbin, place the bobbin on the bobbin-winder spindle and push it up against the shoulder until it is in line with the bobbin-winder latch. Drawing the thread from the unwinder, pass it under and between the tension disks, through the eyelet, and a few times around the bobbin. Push the bobbin-winder pulley against the balance wheel and press the

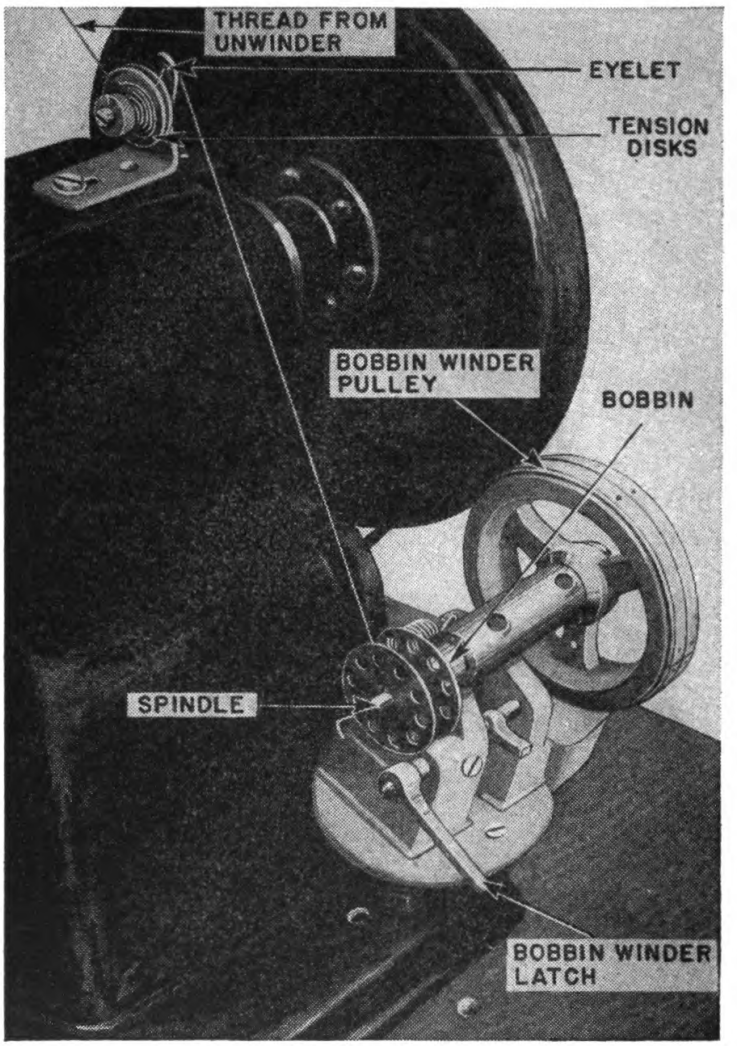

FIGURE 93.—Winding bobbin.

latch against the bobbin. When sufficient thread has been wound on the bobbin, the bobbin winder will stop automatically. Bobbins can be wound while the machine is stitching.

h. To replace bobbin and thread bobbin case.—Hold the bobbin between the thumb and forefinger of the right hand, the thread drawing on the bottom from left to right (fig. 94) and place it on the center stud of the bobbin case. Then push down the latch (fig. 95). Draw the thread out through Slot No. 1 (fig. 94), back

of tension spring, and into Slot No. 2 (figs. 94 and 95), leaving a loose end of thread about 2 inches long above the slide. When closing the slide plate, leave just enough space for the thread to pass through.

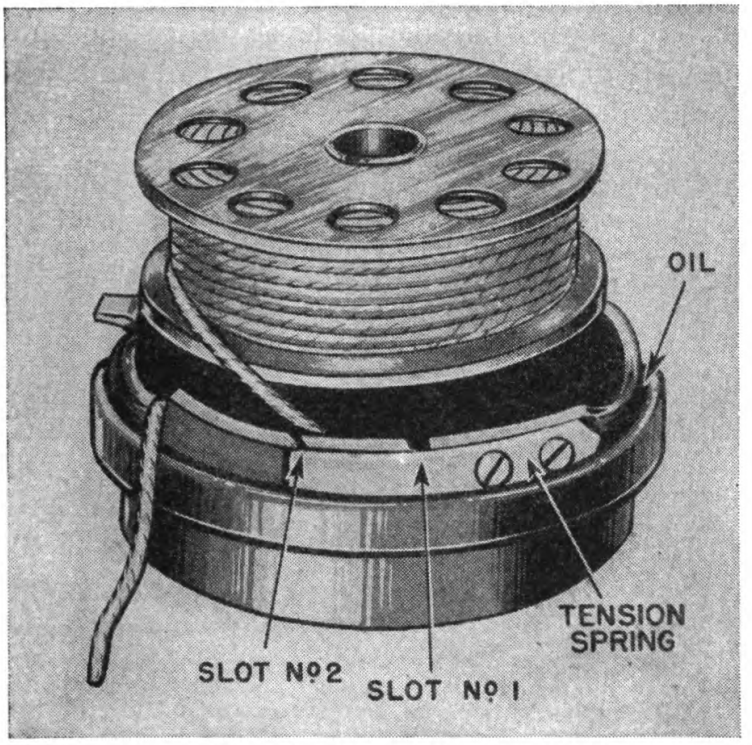

FIGURE 94.—Direction of thread on bobbin.

i. To thread needle (fig. 96).—To thread the needle, pass the thread from the unwinder, through one of the holes in the thread

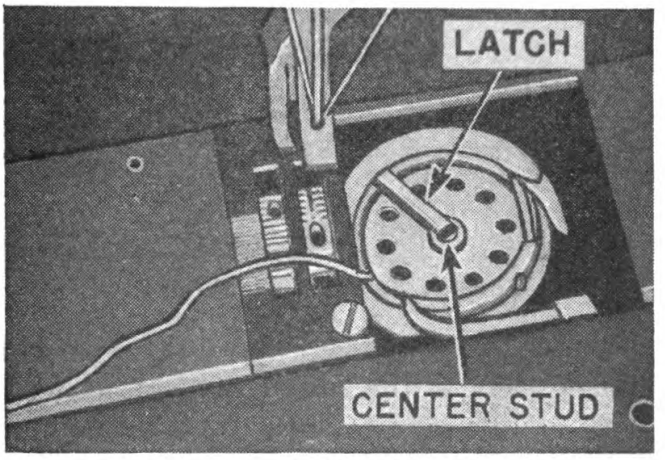

FIGURE 95.—Bobbin case threaded.

oiler, and under the wire guide (which may be raised by prying the end out of its position hole with a screw driver and turning it to the right), then under the oil pad, and out through one of the notches in

the thread oiler; downward to the thread guide, up through one eyelet, down through the other eyelet, over between the tension disk, down around the thread controller and into the tension thread guide, into the thread take-up spring, up through the guide, from right to left through the hole in the take-up lever, down through the guide, back of the lower guide, into the needlebar thread guide, and from left to right through the eye of the needle.

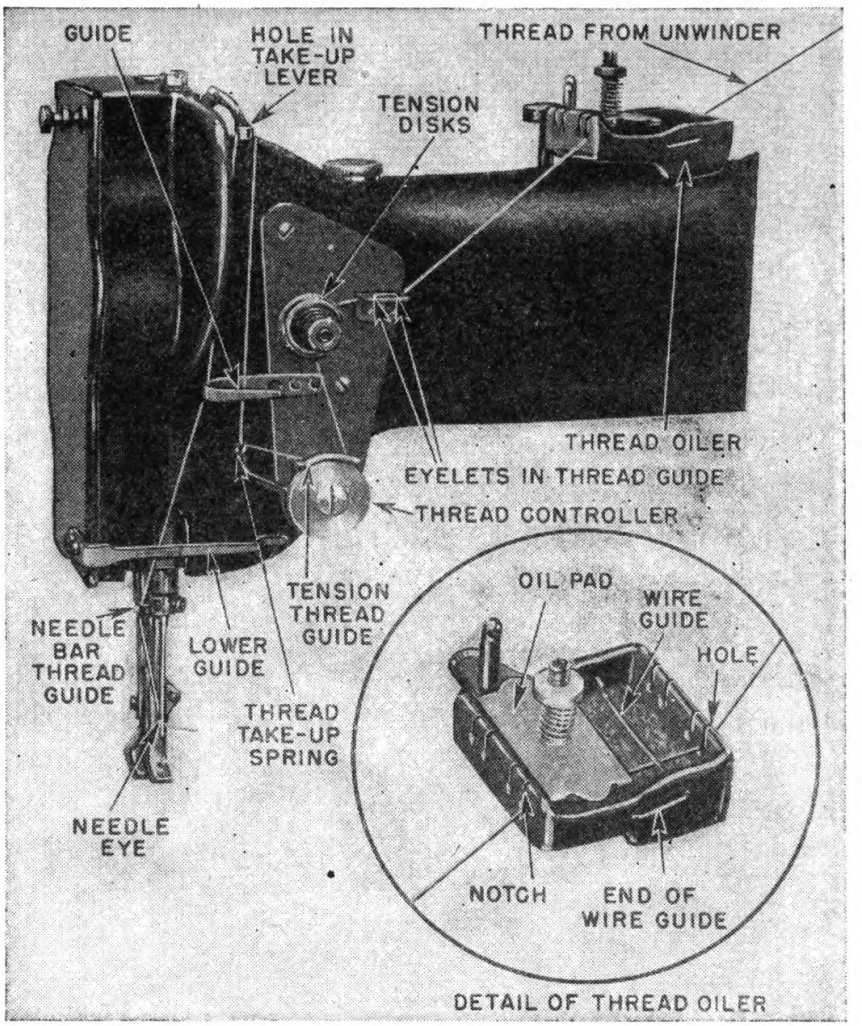

FIGURE 96.—Threading needle.

j. To raise or lower presser feet.—To raise the presser feet, depress the treadle; to lock them in the raised position, move the lever indicated in figure 86 all the way to the left. A slight pressure on the treadle will automatically release the locking device.

k. To prepare for sewing.—With the left hand, hold the end of the needle thread, leaving it slack from the hand to the needle. Turn the balance wheel over toward the body until the needle moves down and up again to its highest point, thus catching the bobbin thread; draw

up the needle thread (fig. 97), and the bobbin thread will come up with it through the hole in the feed dog. Lay the threads back under the presser feet and close the slide.

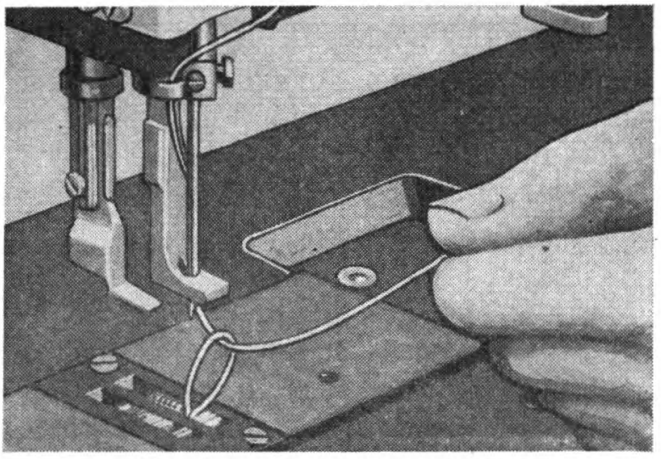

FIGURE 97.—Pulling up bobbin thread.

l. To commence sewing.—Place the material beneath the presser feet, lower the presser feet, and commence to sew, turning the balance wheel over toward the body.

m. To remove work.—Have the thread take-up lever at the highest point, raise the presser feet, draw the work back, and cut the threads close to the goods. Lay the ends of the threads back under the presser feet.

n. Tensions.—The needle and bobbin threads should be locked in the center of the thickness of the material (fig. 98).

FIGURE 98.—Perfect stitch (cross section).

(1) If the tension on the needle is too tight, or if that on the bobbin thread is too loose, the needle thread will lie straight along the upper side of the material (fig. 99).

FIGURE 99.—Tight needle-thread tension (cross section).

(2) If the tension on the bobbin thread is too tight, or if that on the needle thread is too loose, the bobbin thread will lie straight along the under side of the material (fig. 100).

FIGURE 100.—Loose needle-thread tension (cross section).

o. To regulate tensions.—(1) The tension on the needle thread is regulated by the thumb nut (fig. 96) at the front of the tension disk on the front of the machine. To increase the tension, turn this thumb nut to the right; to decrease it, turn the nut to the left.

(2) The tension on the bobbin thread is regulated by the screw nearest the center of the tension spring on the outside of the bobbin case (fig. 94). To increase the tension, turn this screw to the right; to decrease it, turn the screw to the left.

p. To regulate length of stitch.—(1) The length of stitch is regulated by the feed-regulating spindle (fig. 101) at the right of the balance wheel.

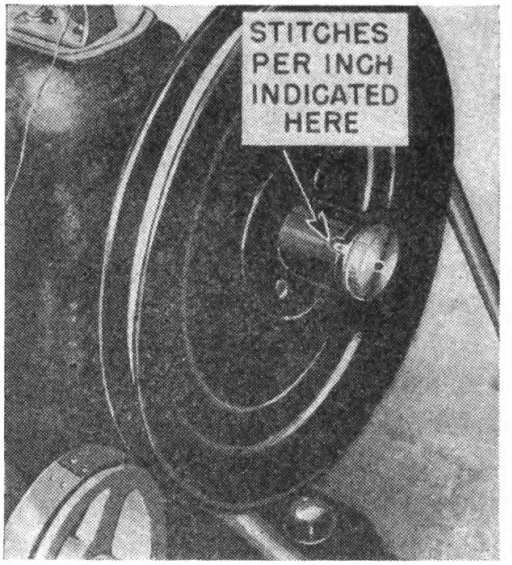

FIGURE 101.—Stitch regulator.

(2) To lengthen the stitch, turn the feed-regulating spindle toward the body; to shorten the stitch, turn it from the body.

q. To regulate pressure on material.—To increase the pressure, turn in the thumbscrew at the back of the machine (fig. 87). To decrease the pressure, turn this thumbscrew out. The pressure on the material should be sufficient only to enable the feed to move the work along evenly.

r. Seams.—(1) The plain seam (fig. 102) is used by itself or as a part of a more complicated seam.

(2) The french seam (fig. 103) is used mostly for tops and seats. Make a plain seam first, then fold the edges back away from the seam and add the two additional rows of stitching, sewing the joined pieces to a piece of backing material.

(3) The cord welt seam (fig. 104) used particularly in leather seat covers, is made by doubling a piece of material around a cord and

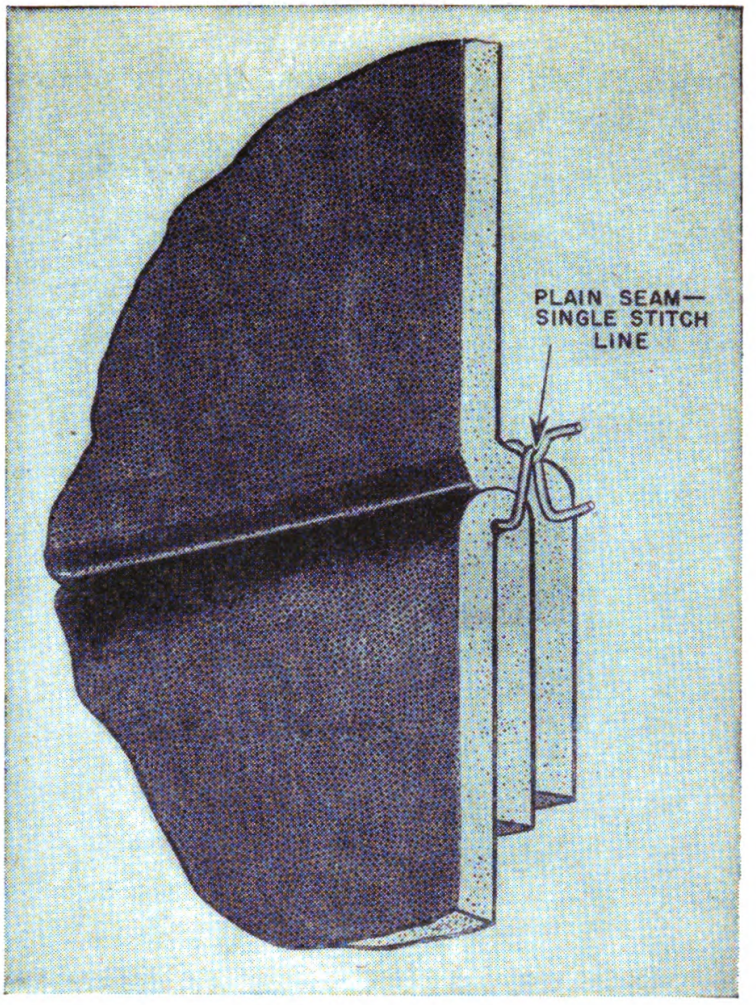

FIGURE 102.—Plain seam.

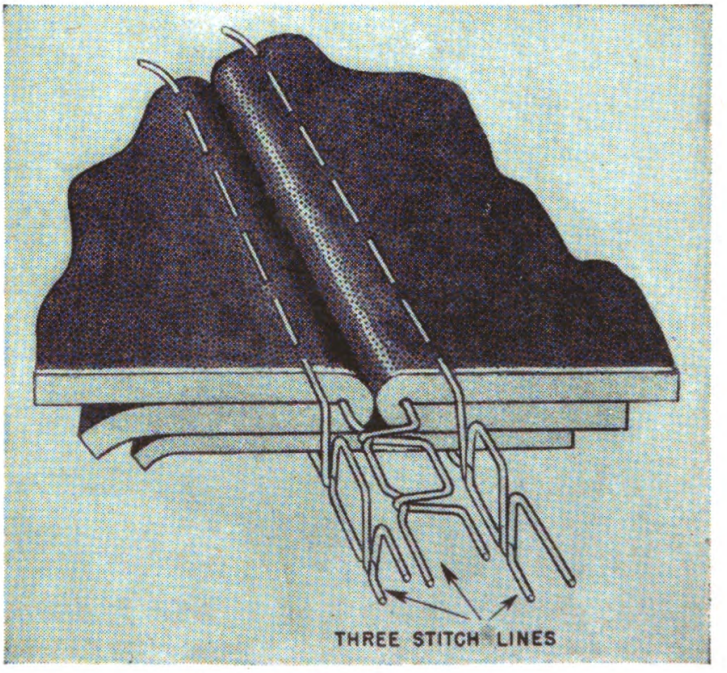

FIGURE 103.—French seam.

fastening it with a plain seam. The strip thus formed is then sewed between the two pieces to be joined.

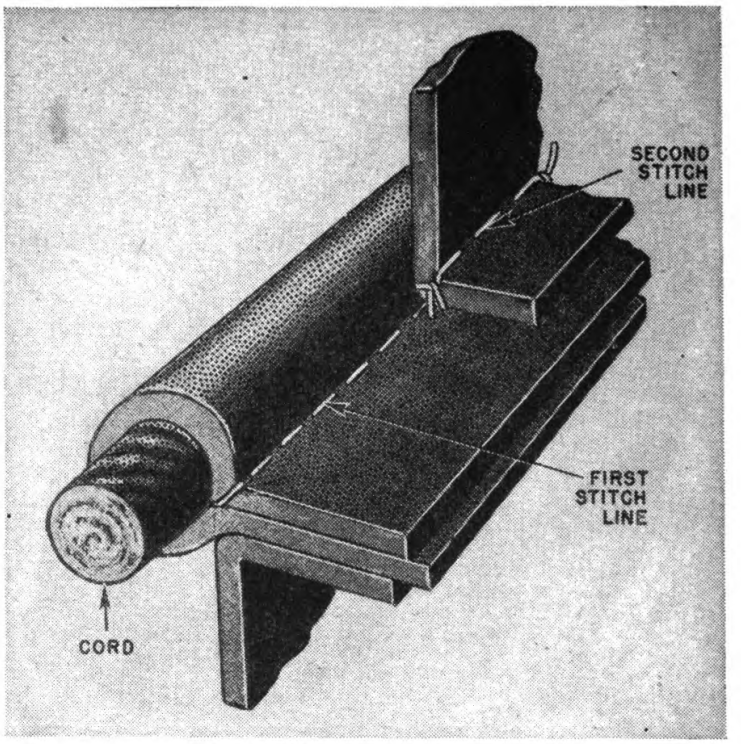

FIGURE 104.—Cord welt seam.

(4) Figures 105 and 106 show alternative methods of binding mats or carpets.

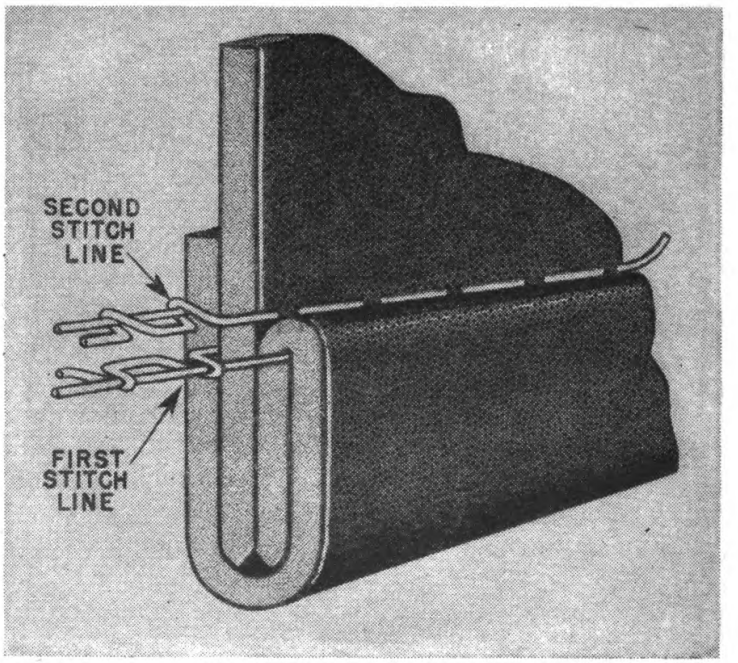

FIGURE 105.—Roll stitching.

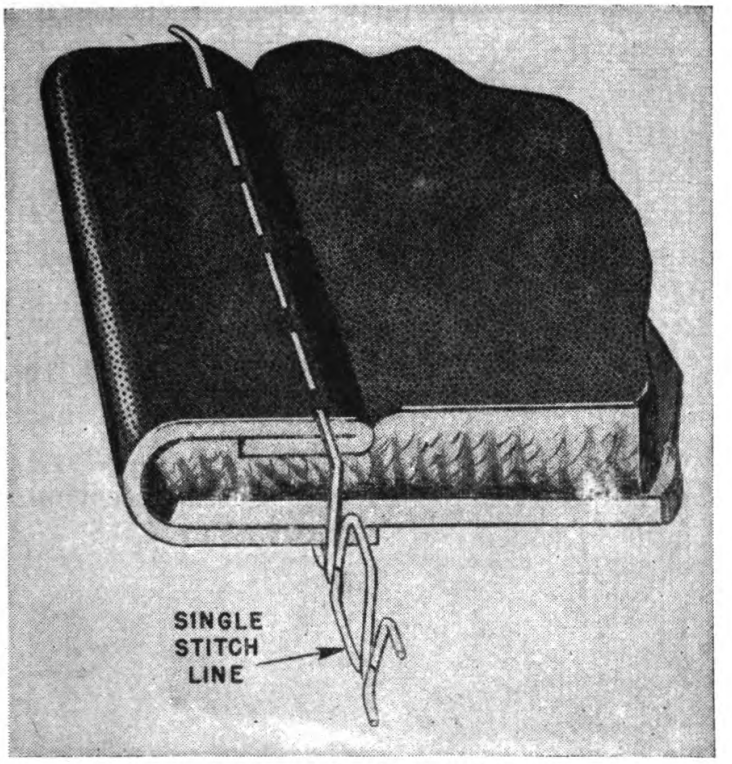

FIGURE 106.—Mat binding.

(5) To use the method shown in figure 105, make a plain seam first by sewing the binding to the carpet. Then roll the binding around underneath the mat and stitch a second row along the turned-over

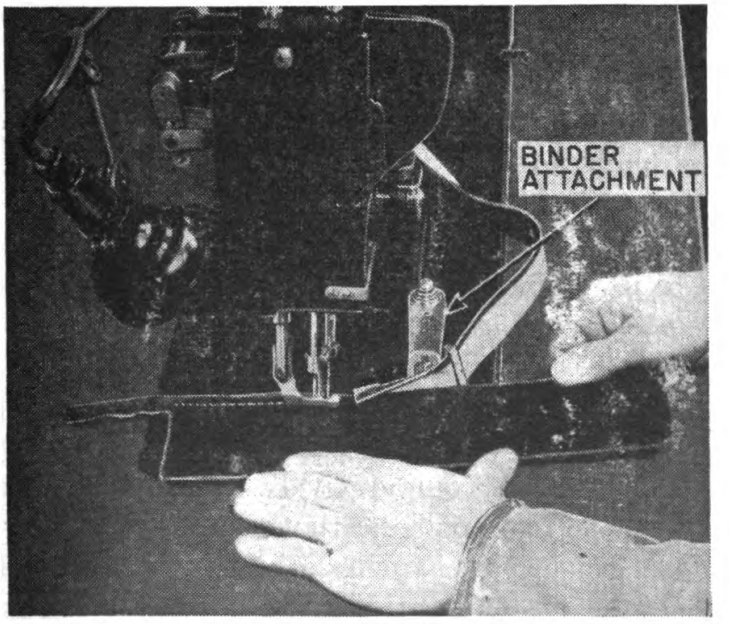

FIGURE 107.—Use of binder attachment.

edge of the binding. If the material is carpet, these stitches will disappear in the nap; thus all sewing in the seam will be invisible.

s. Binder attachment.—Using the binder attachment for the sewing machine (fig. 107) makes the application of bindings to cardboard and other materials easier and faster.

20. Upholstering seat cushions.—*a. Steel frame and springs.*—After stripping the old upholstery, examine the assembly (fig. 73) for broken or damaged springs. If any are found, replace them. Next, replace any missing wire hooks needed to tie the springs together. Cut out a jute insulator enough larger than the top of the frame to allow about 2 inches to fold down over the top wire all around, and hand sew it to the top wire of the frame with a curved needle and flax twine. Place two layers of 2-inch cotton batting over the insulator, turn them down over the front, back, and ends for a

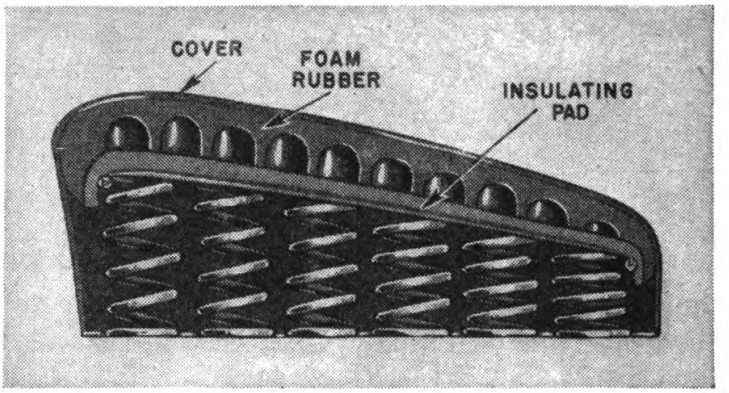

FIGURE 108.—Cross section of seat with foam rubber over springs.

couple of inches, and fix them in place with a twill cover, usually by hooking the bottom of it to spring tie wires. Dimensions of the outer cover may be obtained either from the seat or from the old cover. Pull it over the entire assembly and fasten it to the frame at the bottom with C-clamps. Special metal-binding devices removed in repairing may be used again by squeezing them with pliers.

b. Foam rubber over springs (fig. 108).—Foam rubber over springs may be substituted for cotton batting. Press the tacking tape on the foam-rubber pad inward against the coil springs and hog-ring it to them (par. 17*j*) to hold the pad securely in place. No twill covering is required. Sometimes a comparatively thin layer of cotton batting is added, between the foam pad and the cover.

c. Wood base.—If the steel-spring assembly is nailed or stapled to a wooden base, the first operation is to cover the entire spring assembly with burlap and tack it to the wood. Then proceed as with a

metal base, except that the cover must be tacked to wood instead of being fastened with C-clamps or metal binders.

d. Full depth foam rubber.—Full depth foam rubber construction (fig. 109) uses a wooden frame covered with plywood for the bottom of the seat. Bore several breather holes in the plywood to permit the escape and intake of air as the cushion flexes. Ordinarily, a molded cushion is used, which is purchased in the size and shape required, and has a tacking tape cemented to the bottom. Tack the tape to the wooden frame at the bottom, holding the foam rubber securely in place. Pull the cover over the foam rubber and tack it to the base to complete the job. This type of construction is now extensively used for truck and bus seats, as well as for fire engines and crash trucks.

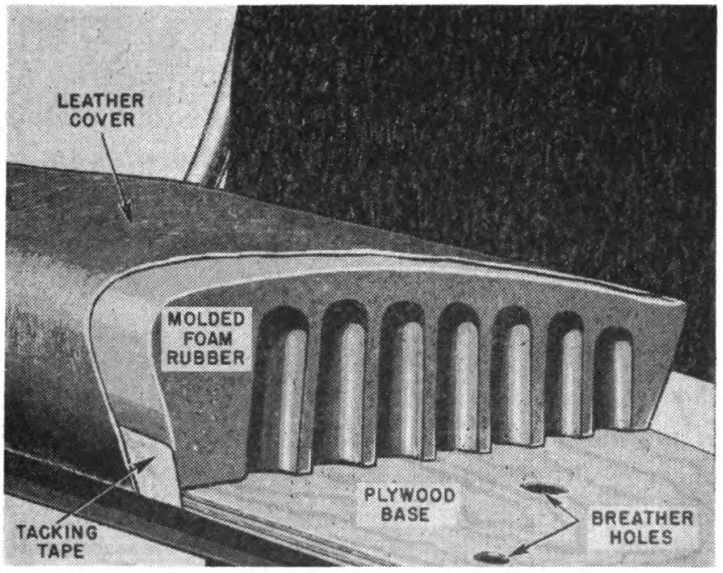

FIGURE 109.—Cross section of molded, full depth, foam-rubber seat.

21. Back cushions.—Back cushions are constructed like seats. They may have softer springs, or softer foam rubber than that used for seats, but they are upholstered in the same way.

22. Making carpet and rubber mats.—*a.* If a number of pieces of the same size and shape are required, a pattern should first be cut from paper or artificial leather. If only one piece is to be made, an experienced man may take the dimensions and cut it directly from the roll. However, even when only one piece is to be made, it is safer for a beginner to first make a paper pattern and fit it to the vehicle, because by this method there is little chance of spoiling and wasting material.

b. Carpet mats are bound with bias tape on the sewing machine. They are fastened to the floor with rubber cement or carpet fasteners. Rubber mats are usually cemented to the floor with rubber cement.

23. Repairing tarpaulins and curtains.—*a.* Work on tarpaulins consists mainly of patching and replacing ropes. Tarpaulins are usually patched with a reinforcement of duck under the torn part and sewed back and forth many times over the damaged area on the sewing machine. To replace grommets, use the hollow punch and dies described in paragraph 18*m*. Splice the tie ropes to the grommets and whip the ends with waxed flax twine to prevent them from unraveling. Attach fasteners, usually Burco, to window flaps in end curtains, with the hand tools described in paragraph 18*l*. Roll-up straps are fastened to the bows by metal hasps and bolts. Sew the buckles on the tarpaulin with a sewing machine.

b. To sew heavy leather by hand, use two blunt needles, making holes with an awl for the stitches. Cut off enough thread, wax it, and put each end through one needle. Begin to sew by passing one of the needles through the first hole and pulling through half the length of the thread. Then pass first one needle and then the other through the next hole from opposite sides and pull the stitch tight, repeating this process until the sewing is completed. Blunt needles are used because a sharp one might catch or split a thread previously drawn through the hole by the other needle.

24. Replacing door and cowl panels.—Most door and cowl panels of Army vehicles are simply cut with shears from black cardboard, bound with bias tape on the sewing machine, preferably using the binder attachment (fig. 107), and fastened in place with saddle tacks or whatever other means was used on the old panel. Door panels for passenger cars are purchased from the manufacturer to match the interior trim, ready for installation.

25. Miscellaneous interior trim.—*a.* Interior trim in passenger cars, such as the items shown in figure 110, is installed in different though similar ways by various manufacturers. When stripping the old parts, therefore, observe how they were installed, and install the new ones in the same way. An example of the installation of headliner, wind hose, and wireon around a rear door is shown in figure 110.

b. In this vehicle the tacking strip is a strip of compressed paper, fastened in the edge of the metal body, which will hold tacks. The wind hose is tacked to the tacking strip with 6-ounce tacks spaced 2 inches apart. The wireon is tacked through itself and through the wind hose to the tacking strip with 6-ounce tacks spaced 1½ inches apart. Then the headliner is tacked through the material, wireon, and wind hose to the tacking strip with 6-ounce tacks spaced 1 inch apart. The wireon is folded over the edge of the headliner material to conceal the tacks, and tapped down with a hammer.

c. The wire support arch is inserted through a pocket in the headliner to hold it up.

d. The headliner wire support clip anchors one wire support arch and the headliner rigidly to the metal top so that the headliner may be drawn tight backward and forward from that position.

e. The deadener pad is cemented to the inside of the body metal.

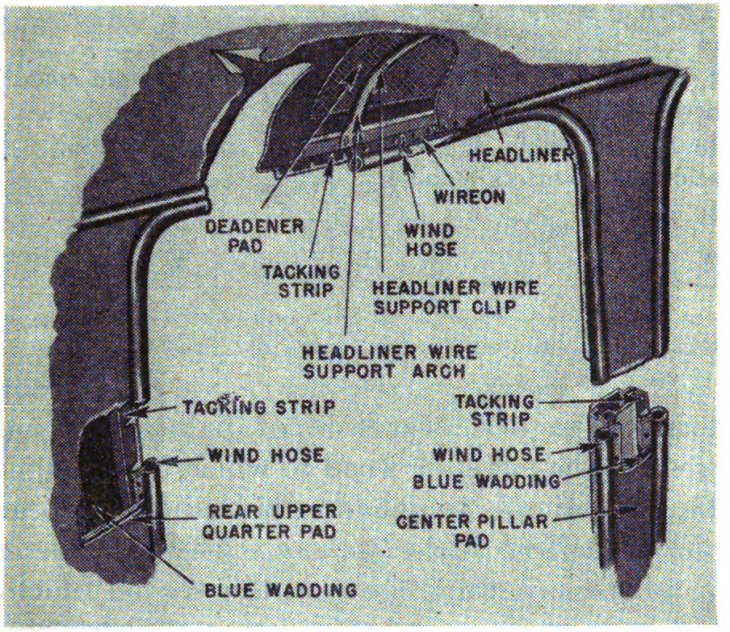

FIGURE 110.—Interior trim around rear door.

f. The rear upper quarter pad is blind-tacked through the pad cover cloth, blue wadding, cardboard, and wind hose to the tacking strip with 1-inch brads; the cover cloth is pulled over the heads of the brads.

g. Blue wadding is cemented to cardboard and covered with cloth.

h. The center pillar pad is blind-tacked through the pad cover cloth, blue wadding, cardboard, and wind hose to the tacking strip with 1-inch brads; the pad cover cloth is pulled over the heads of the brads.

SECTION IV

PAINTER

26. General.—The basic function of paint on a motor vehicle body is to preserve the metal or wood to which it is applied. Another very important function is to enhance the vehicle's appearance.

a. Synthetic olive-drab lusterless enamel.—Since the initiation of the national defense program, however, this second function has been largely abandoned insofar as Army motor vehicles are concerned. Camouflage is considered more important than ornamentation in paint. Although a few administrative and metropolitan vehicles are still finished with glossy lacquer, all tactical vehicles are now painted with the new, synthetic, olive-drab, lusterless enamel. This finish was developed to blend with the average landscape without reflecting light, which might reveal the presence of the vehicle even at a considerable distance.

b. Blue-drab stencil enamel.—It was found that white stencil enamel, formerly used for marking vehicles, could be photographed from the air. Therefore, this has been superseded by the newly developed blue-drab stencil enamel which cannot be photographed from the air. It cannot be read by the normal eye at a distance greater than 75 feet.

c. Spraying and brushing.—Almost all motor vehicle painting today is done by spraying because this produces the best, quickest, and easiest job. However, the synthetic, olive-drab lusterless enamel, as well as the preparatory primer, may be brushed on if no spray equipment is available.

d. Care of lusterless enamel.—(1) In order to preserve the camouflage features of the lusterless finish, more care must be taken with vehicles. To secure the necessary degree of dullness, it was necessary to adopt a relatively rough paint. A dried coat of this paint contains thousands of angular particles of pigment which break up the surface so that a minimum of light is reflected. Continued friction or rubbing will eventually smooth down the surface and produce a glossy finish which reflects light. This glossing-up must be carefully avoided. As careless washing is one of its principal causes, the vehicle should not be washed oftener than once a week, and then only with a sponge or soft rag. The surface should never be rubbed or wiped, except while wet, or a gloss will be developed.

(2) Continual friction of wax-treated tarpaulins on the sides of a vehicle will also produce a gloss. This may be removed by washing with degreasing solvent.

(3) It is not necessary to keep the new lusterless vehicles as scrupulously clean as was customary when glossy paint was used. In fact, a certain amount of dust increases the camouflage value of the paint.

(4) Grease spots should be tolerated as far as possible. The relatively porous paint soaks up oil as a blotter absorbs ink. Whatever grease cannot be removed by washing with degreasing solvent should be allowed to remain.

e. Fading.—The new paint has some tendency to fade. Each organization should provide itself with standard color chips of olive-drab and blue-drab, which may be obtained from the Engineering Division, Holabird Quartermaster Depot, Baltimore, Md. When the color has faded until it is definitely lighter than the standard, much of the camouflage value is gone and repainting is necessary. Tests at Holabird Quartermaster Depot indicate that repainting will probably be needed once yearly for olive-drab enamel and twice yearly for blue-drab.

27. Shop equipment.—*a. Booths and hoods.*—A permanent spray-painting shop requires well ventilated and well illuminated booths (fig. 111) or hoods. The booth is simply a room or compartment open at one end which accommodates one or more automobiles. The vehicles to be painted are driven in at the open end. The hood is a large sheet-metal structure hung over the scene of painting. Both the booth and the hood are provided with exhaust fans and ducts to carry off the fumes. They are usually manufactured of sheet metal in sections so that any desired length or capacity can be obtained.

b. Portable floodlights.—Portable floodlights conveniently provide good illumination directly on the area being painted. Their use will avoid many places being skipped or slighted. All lights used should be of the vaporproof type.

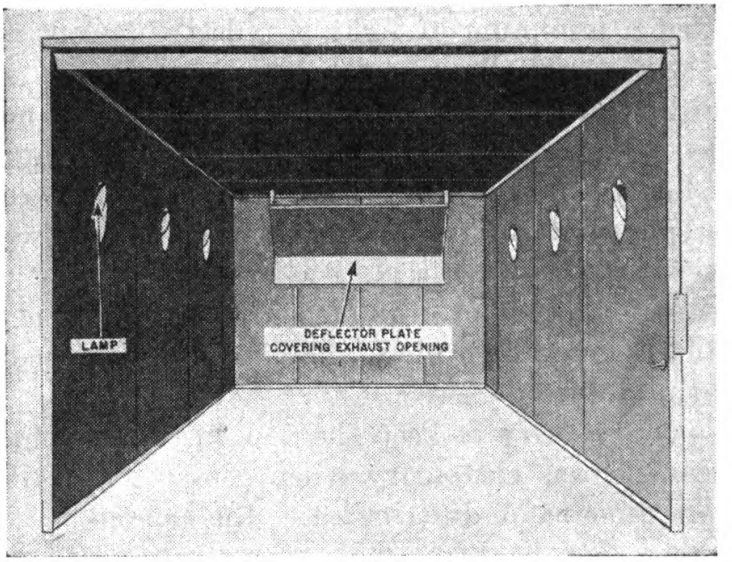

FIGURE 111.—Auto spray booth.

c. Compressed air.—A source of compressed air, preferably at a pressure of about 100 pounds per square inch, and in sufficient volume, is a basic requirement. Each spray gun, of the type ordinarily used for automobile painting, requires about 7 cubic feet of free air per minute. If the shop is piped for compressed air from a large compressor, the air main running through the shop may be

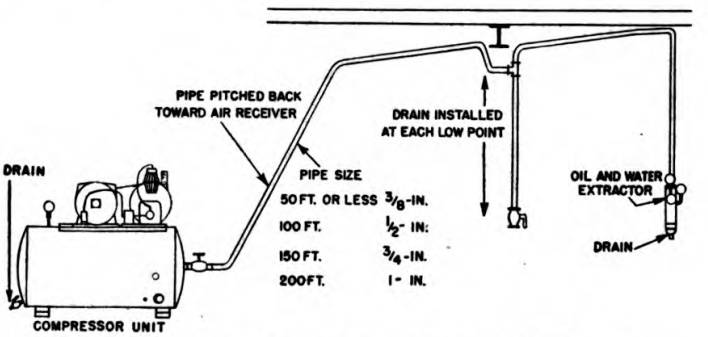

FIGURE 112.—How air line should be installed.

used; otherwise, a smaller compressor, equipped with a storage tank and operated by an electric motor is installed in the paint shop (fig. 112). For field operations, a portable, gasoline-engine-driven outfit (fig. 113) is used. If a vehicle having air brakes is available, the spray gun may be connected to the tire inflation valve of the air brake system.

d. Oil and water extractor.—(1) An oil and water extractor (figs. 112 and 114) sometimes called an air transformer, is connected at the end of the pipe from the compressor. This device has three functions: first, it separates oil, dirt, and water from the compressed air before it enters the spray gun, which is essential since clean, dry air is necessary for a good paint job; second, the extractor reduces the line pressure to any desired working pressure for the spray gun; third, it provides hose connections for one or more spray guns. The extractor is usually provided with a gage that registers the line pressure and always with one or more gages that indicate the working pressure. If the extractor has only one regulator, two spray guns may be used simultaneously,

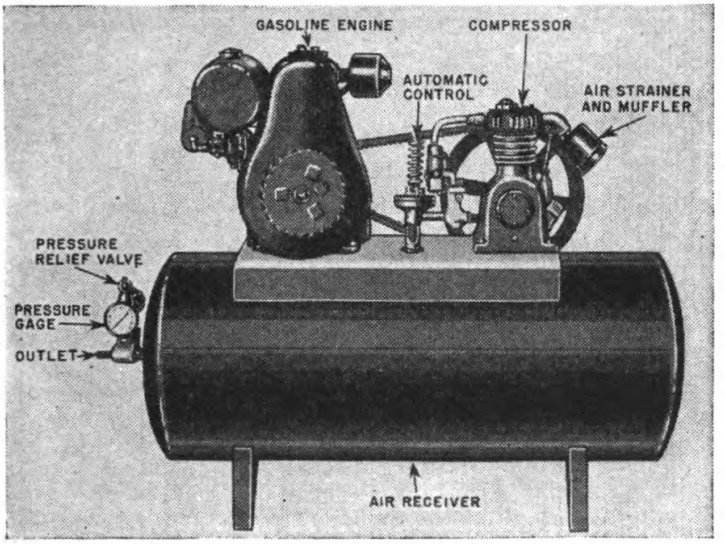

FIGURE 113.—Portable, gasoline-engine-driven compressor.

but both must use the same working pressure. If it has two regulators, as shown in figure 114, two spray guns may be used at the same time, each employing a different working pressure. Figure 115 shows a cross section drawing of an air transformer and indicates its principal parts.

(2) It is extremely poor practice to mount the oil and water extractor on or even near the compressor unit. The temperature of the air is greatly increased as it passes through the compressor and the compressed air must be cooled before the moisture in it will condense. If the air is still warm when it passes through the oil and water extractor, the moisture in it will not be effectively removed; it will still be in the form of vapor. As the air cools in the hose beyond the extractor, the moisture in it will condense

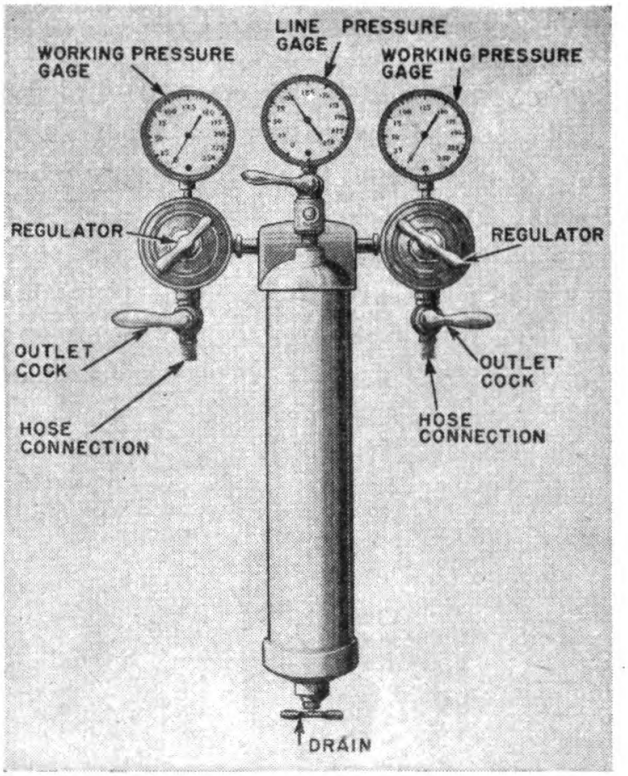

FIGURE 114.—Oil and water extractor or air transformer.

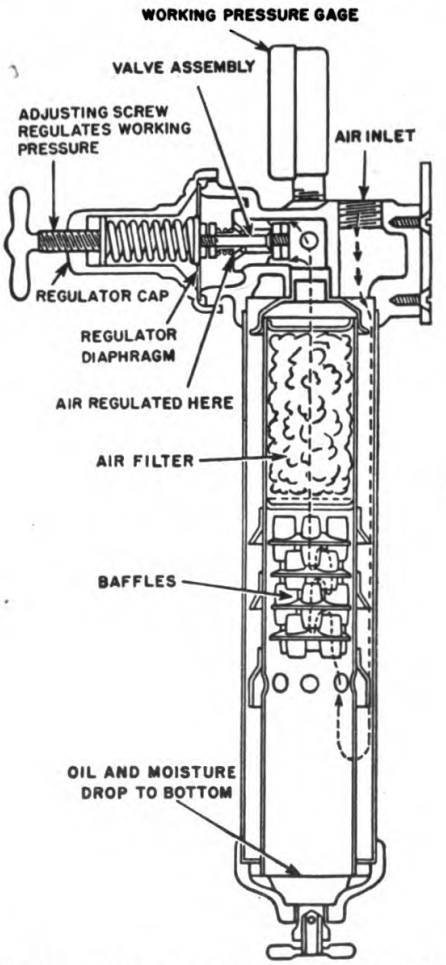

FIGURE 115.—Cross section of air transformer.

into drops of water. The extractor should always be installed at least 25 feet from the compressor and farther if possible.

(3) The air line should slope back toward the compressor so that condensed moisture will flow back into the air receiver where it can be removed by opening the drain cock. Every low point on an air line acts as a water trap and each such point where the air line dips under a joist should be fitted with a drain cock (fig. 112).

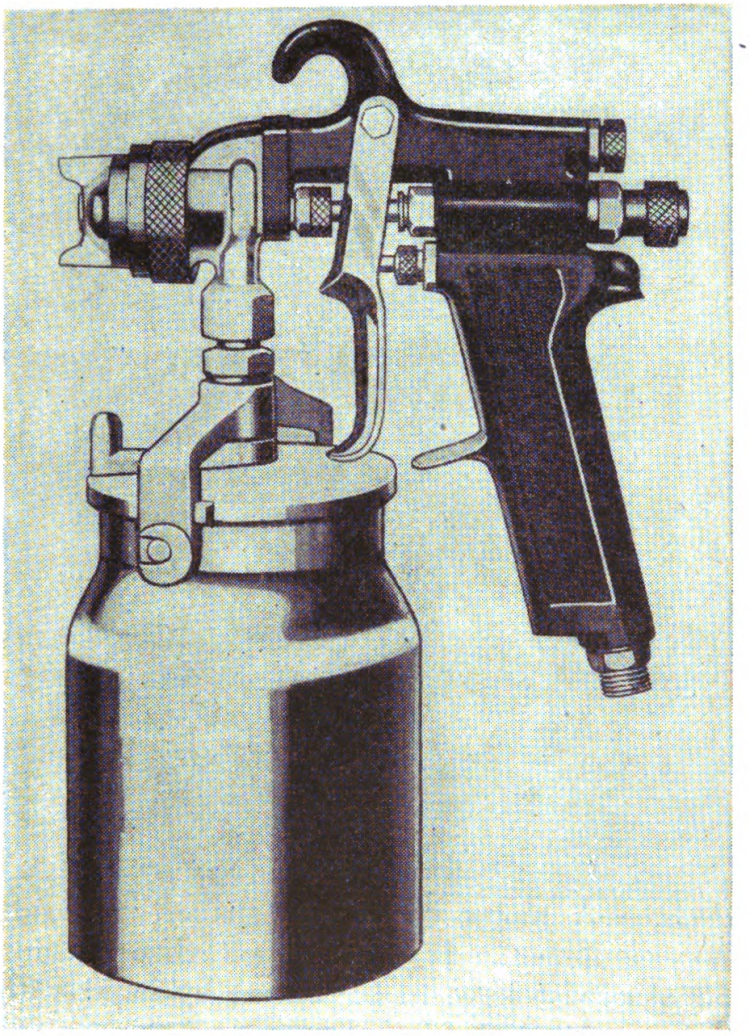

FIGURE 116.—Spray gun for body painting.

e. Hose.—(1) Air hose having an inside diameter of 5/16 inch, manufactured especially for the purpose, is generally used, although 1/4-inch hose is sometimes used for small outfits.

(2) Paint tanks are available which, in addition to the air hose, require a fluid hose to convey the paint to the gun. Hose for this purpose is larger—usually 3/8- and 1/2-inch inside diameter. Such

tanks are suitable for maximum production since time need not be taken out to refill small containers, which empty rather quickly. Cup-type guns, which require only air hose, are more generally used for Army work.

(3) All necessary fittings are available for making any desired hose connections.

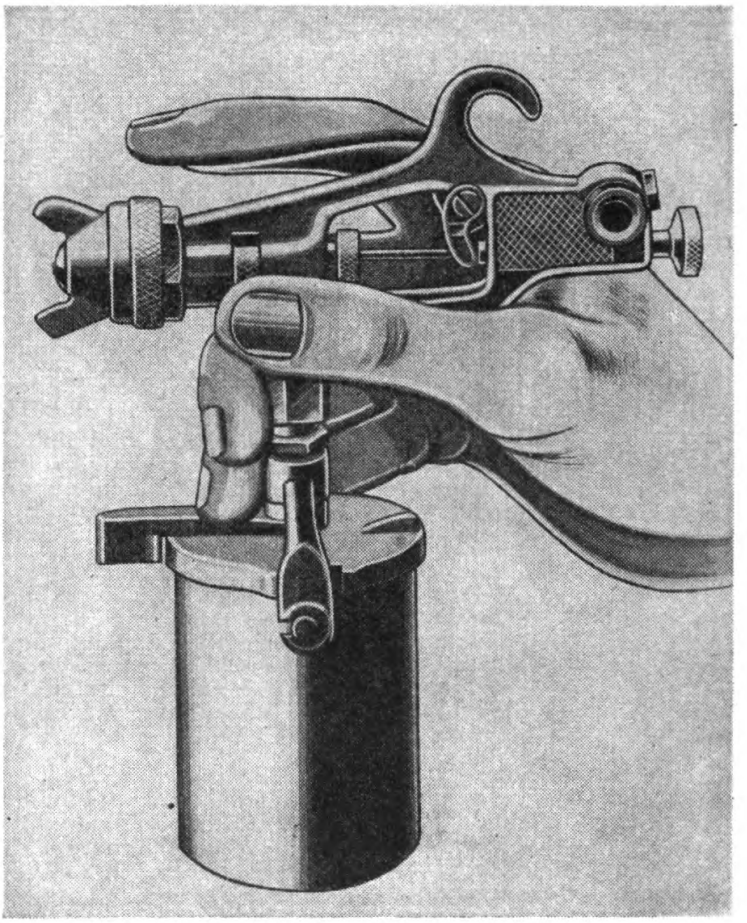

FIGURE 117.—Spray gun for stenciling.

f. Can shaker.—A motor-driven can shaker is a valuable piece of paint-shop equipment. It saves much time in mixing paint, which would otherwise have to be stirred by hand with a paddle.

g. Hydraulic jack.—A good hydraulic jack is required, since the wheels of a vehicle are usually removed for painting. Strong wooden or iron horses are also needed to support the vehicle for painting while the wheels are off.

28. Tools.—*a. Spray guns.*—Several paint spray guns are required for painting, according to the capacity of the shop. A gun of the usual size is required for general body work and a smaller one for stenciling. The latter is known as a "touch-up" gun because it is also

used for that purpose. Figure 116 shows the type of spray gun used for body painting and figure 117 shows the type used for stenciling.

b. Respirator.—The painter should wear some type of respirator when using the spray gun. This is required by law in many States. A popular type of respirator, which covers the nose and mouth and is held on by an elastic head band, is shown in figure 118. The round filter pads in it are easily replaced.

FIGURE 118.—Respirator.

c. Electric sander and buffer.—(1) Portable motor-driven, flexible disk sanders (fig. 119) are occasionally required for smoothing the body or fender metal before it is painted, although this is not usually the work of the paint shop. They should not be used within the spray-painting area.

(2) Ordinarily the same tool is not used both for sanding and buffing, because the sander rotates much faster than the buffer. However, combination sander-buffers are available, which operate at two speeds controlled by gear shifts.

d. Stencil key sets (fig. 120).—Stencil key sets can be used for drawing any letter or number on stencil paper. To use them, lay them in the proper positions, mark around the edges, and cut out the letters with a stencil knife. The usual sizes are 1½-, 2-, 3-, and 4-inch.

e. Laying-out tools.—Straightedges, a yardstick, a steel square, and dividers are used for laying out lines to guide the location of letters and insignia when they are stenciled. Guide lines may otherwise be made by snapping a chalked string against the body.

f. Gasoline blow torches.—Gasoline blow torches are used sometimes for burning off paint. Open flames should never be allowed within the spray-painting area.

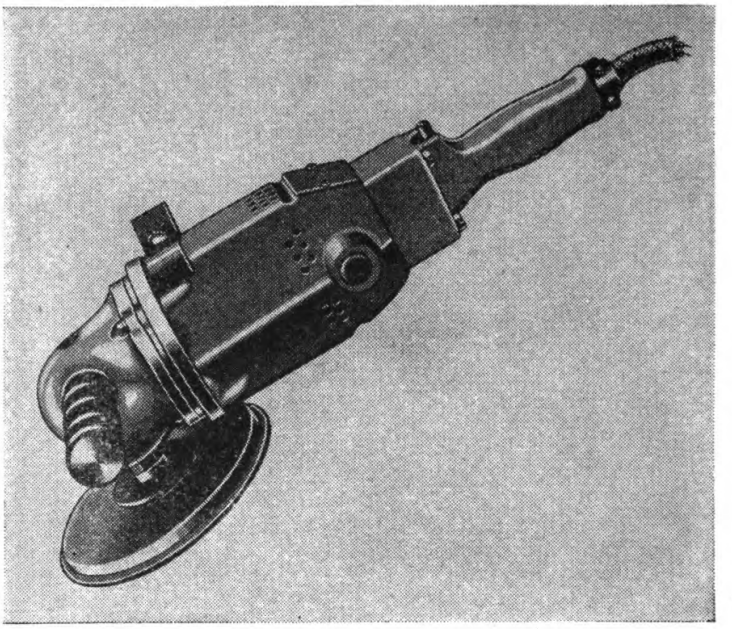

FIGURE 119.—Portable electric sander.

g. Scrapers.—Scrapers made of bronze, which do not produce sparks when rubbed on metal or concrete surface, are used for cleaning paint residue out of spray booths and off the floor.

h. Other tools.—Other tools required in the paint shop are paint and enamel brushes, wire brushes for cleaning off loose paint and rust, putty knives, and scrapers for removing old paint. Razor-blade scrapers are useful for removing paint from glass. A 16-ounce graduate glass is needed for mixing paint and thinners in the required proportions.

29. Supplies.—*a. Supplies for preparing surfaces.*—Paint-removing solutions, cleaning solutions, rust-removing solutions, and sandpaper of the kind that can be used wet or dry are required for preparing surfaces.

b. Masking tape.—Masking tape is required to cover all body parts that are to be protected from the spray. Scotch tape is superior to gummed tape for this purpose, since it is more easily removed without leaving any marks. Tape alone is used to mask small areas. For larger areas, such as windows, the tape is used to fasten paper over the area to be protected.

c. Primers.—Primers are used to form a bond between the bare metal, or the old paint, and the new coats. Most primers require thinners.

d. Surfacer.—Surfacer is used between the primer and the new finishing coats to make the surface perfectly smooth.

e. Sandpaper disks.—Sandpaper disks are kept on hand for the motor sander, as well as polishing pads and solution for the electric buffer. A different solution is used for hand polishing.

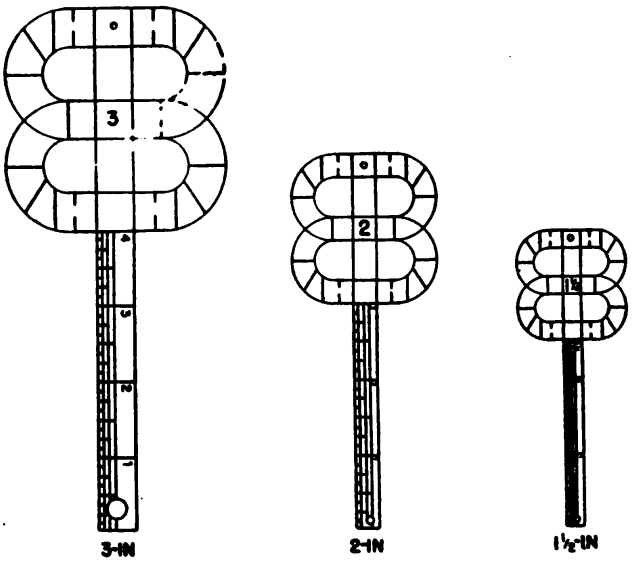

FIGURE 120.—Stencil key sets.

f. Paint.—Olive-drab lusterless synthetic enamel is used for most finishing coats and blue-drab lusterless enamel for most stenciling. Other colors are required for insignia. Lacquer is occasionally needed, and black rubber paint is used for tires and rubber matting.

g. Stencils.—Brass stencils in 1-, 2-, 3-, and 4-inch sizes are sometimes used, but the most satisfactory stencils are probably ready-cut paper ones that are used once and thrown away. Stencil paper is required for cutting special stencils. The ties in the letters are cut out with a sharp knife or razor blade. (Ties are cross pieces in an enclosed letter like O, which keep the center of the stencil in place.) Spray on the lettering, pull the stencils off, and throw them away. The lettering then looks like ordinary printing and presents a very neat and legible appearance.

h. Rags.—An abundance of rags is required at all times for wiping off paint spilled or applied by mistake, for cleaning spray guns, and the like.

30. Operation and care of spray guns.—A popular spray gun is shown in cross section in figure 121, with its parts indicated. Other spray guns are similar. This gun can be used with either a siphon cup or a pressure container.

a. Pressures.—(1) No set rule can be given for the pressure to be used in a spray gun because it varies considerably with the nozzle combination, the material being sprayed, and the work being done. Several different air nozzles, material nozzles, and material needle valves are available for the same guns. Combinations of those three parts, as

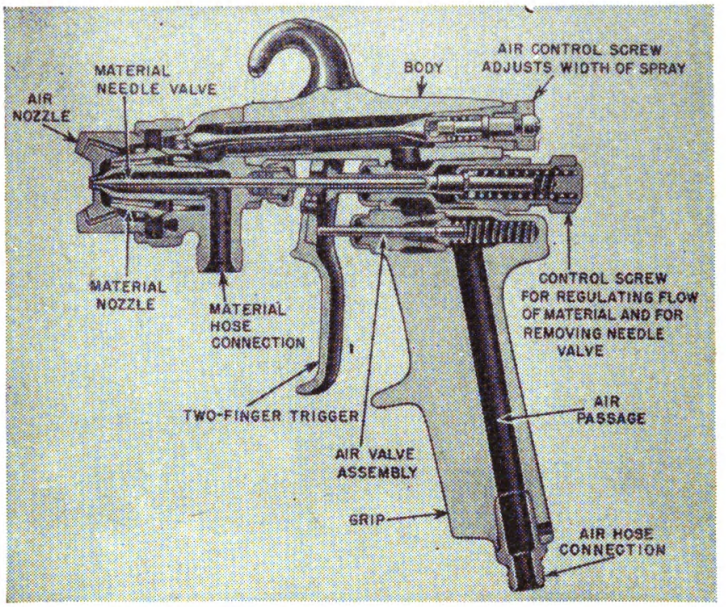

FIGURE 121.—Cross section of spray gun.

prescribed by the manufacturer or foreman, are used for different materials, different types of material containers, and different work. Recommended pressures for these different combinations range from 40 pounds per square inch to 80 pounds per square inch, and consumption of air ranges from 4½ to 18 cubic feet per minute.

(2) Air pressure means pressure at the gun with the gun open. It must be set to allow for the drop in pressure between the regulator and the spray gun. Pressure at the gun can be determined accurately by inserting a pressure gage where the air hose joins the gun; it can be estimated closely from the following: 25 feet of 5/16-inch I. D. (internal diameter) hose has a pressure drop of 5 pounds per square inch; 25 feet of ¼-inch I. D. hose has a pressure drop of 16 pounds per square inch.

(3) In body spraying, a pressure of 55 pounds per square inch is about right for synthetic enamel, and 70 pounds per square inch is about right for lacquer when a siphon cup is used. If a pressure container is used, about 20 pounds per square inch less atomizing pressure is sufficient.

b. Spray width.—Turn air control screw clockwise for a round spray pattern and counterclockwise for a fan. Turn the material control screw clockwise to decrease the flow and counterclockwise to increase it. As the width of the spray is increased, increase the flow of material to get the same coverage on the wider area being sprayed. (See fig. 122.)

c. Spray direction.—Always keep the spray perpendicular, or as nearly perpendicular as possible, to the surface being painted to prevent "dusting," or "overspray" (see par. 32).

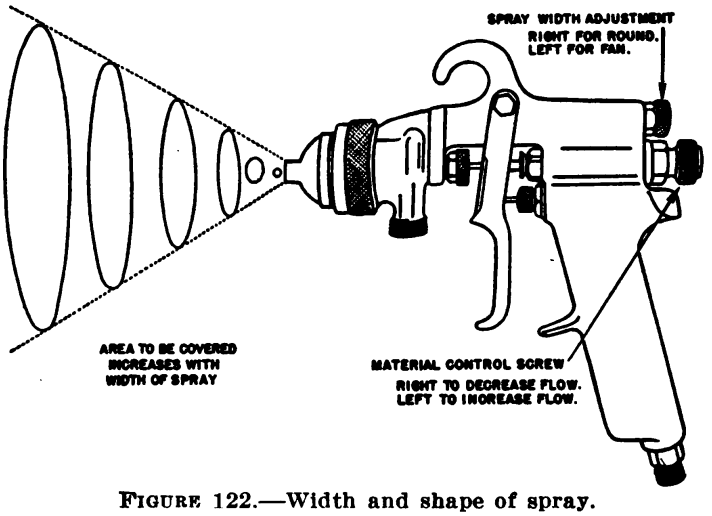

FIGURE 122.—Width and shape of spray.

d. Blowing.—Pulling back the trigger opens the air valve first and then the material valve. Thus the gun can be used for blowing out dust and dirt by pulling the trigger back just far enough to open the air valve. This position can easily be felt because the resistance increases as soon as the material valve starts to open. This method is convenient for dusting off small areas or areas that have been overlooked in general cleaning-up. For complete dusting jobs, use the air hose without any gun attached.

e. How to correct spitting.—"Spitting" means the discharge of spray and air alternately (fig. 123). The three most prevalent causes of spitting are as follows:

(1) Dried out packing around the material needle valve which permits air to get into the material passageway and results in spitting. To correct this, back-up the knurled nut, place two drops of machine oil on

the packing, replace the nut, and tighten it with the fingers only. In aggravated cases, replace the packing.

(2) Dirt between the material nozzle seat and the body or a loosely installed material nozzle. Remedy: Remove the material fluid nozzle, clean the back of the nozzle and the nozzle seat in the gun body with a rag wet with thinner, replace the nozzle, and draw it up tightly against the body.

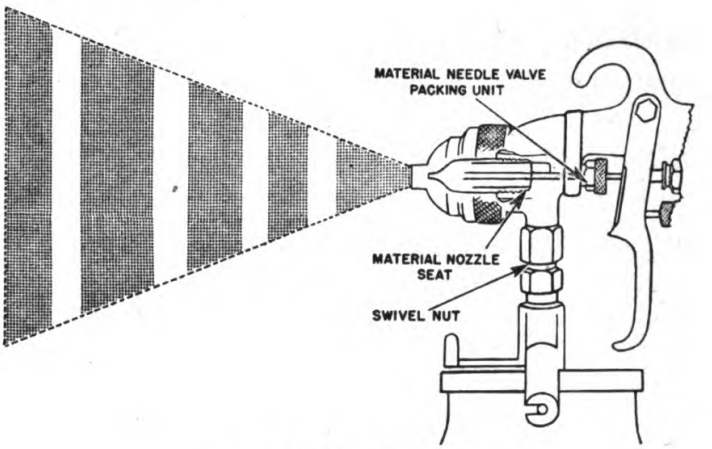

FIGURE 123.—Spitting.

(3) A defect in the swivel nut on the siphon cup or material hose, affecting its fit.

f. How to correct distorted patterns.—Dried material in one of the side ports restricts the passage of air through it, so that the full air pressure from the clean side port forces the fan pattern in the direction of the clogged side (fig. 124). To correct this condition,

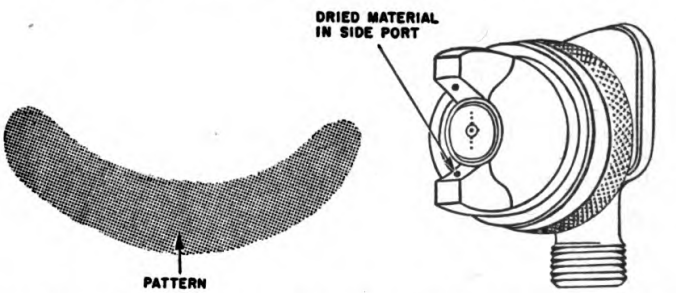

FIGURE 124.—Distorted pattern due to clogged side port in air nozzle.

dissolve the material in the side port with thinner; do not gouge any of the openings with a metal instrument as this may enlarge or mutilate them.

(1) Dried material around the outside of the material nozzle tip restricts the passage of air at one point through the center opening of the air nozzle and results in the pattern shown in figure 125. To remedy this condition, remove the air nozzle and wipe off the ma-

terial nozzle tip with a rag wet with thinner. This pattern can also be caused by a loose air nozzle.

(2) A split spray (fig. 126), or one that is heavy on each end of a fan pattern and weak in the middle, is usually caused by too high an atomizing air pressure. Reducing that pressure will usually overcome

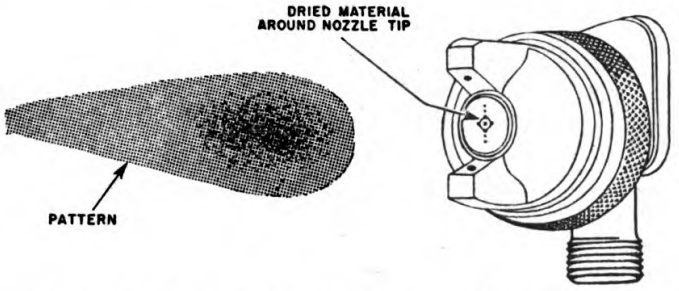

FIGURE 125.—Distorted pattern due to clogged center air opening or loose air nozzle.

this condition. If the air pressure is correct, a split may be caused by attempting to get too wide a spray with thin material. To correct this fault, open the material control needle valve to full position by turning the regulating screw to the left. At the same time turn the spray-width adjustment screw to the right. This will reduce the width of spray, but it will correct split spray.

(3) A fan-spray pattern that is heavy in the middle, or a pattern that has an unatomized "salt and pepper" effect (fig. 127), indicates that the atomizing pressure is not high enough.

FIGURE 126.—Split spray.

31. Cleaning spray gun.—*a. Used with cup container.*—When using the spray gun with a cup container, siphon some thinner or suitable solvent through the gun by inserting the siphon tube in an open container of that liquid (fig. 128). Move the trigger constantly to flush out the passageway and to clean the tip of the needle.

b. Used with pressure tank.—When the gun has been used with a pressure tank, remove the material hose, turn the gun upside down, and pour thinner into the material opening. Move the trigger as in cleaning a gun with a siphon tube.

Caution: The entire gun should never be placed in thinner. It is good practice, however, to place the nozzle and material connec-

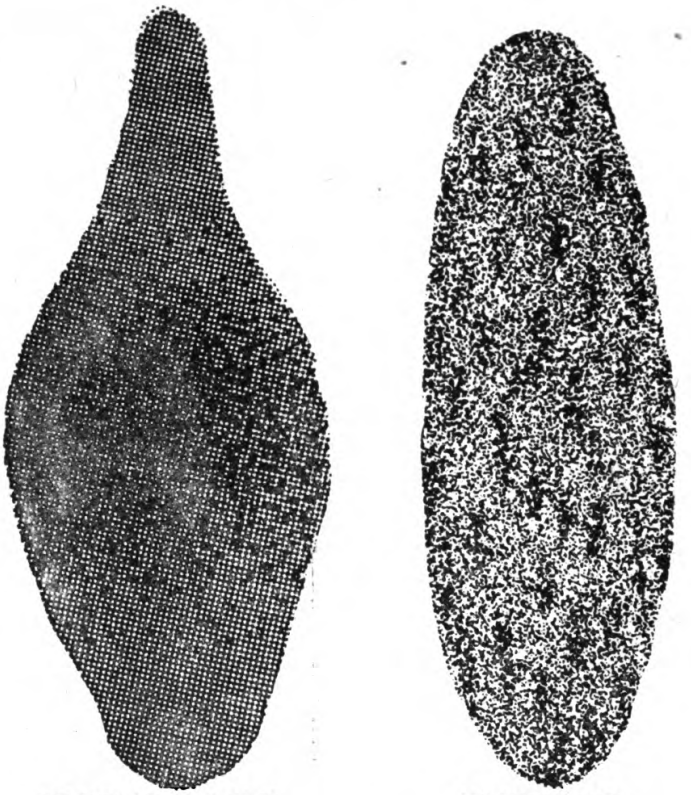

FIGURE 127.—Other faulty patterns.

tion in thinner (fig. 129). The vessel used should be shallow enough to prevent the thinner from reaching the leather packing, as it will dissolve the oil in it and cause the gun to spit.

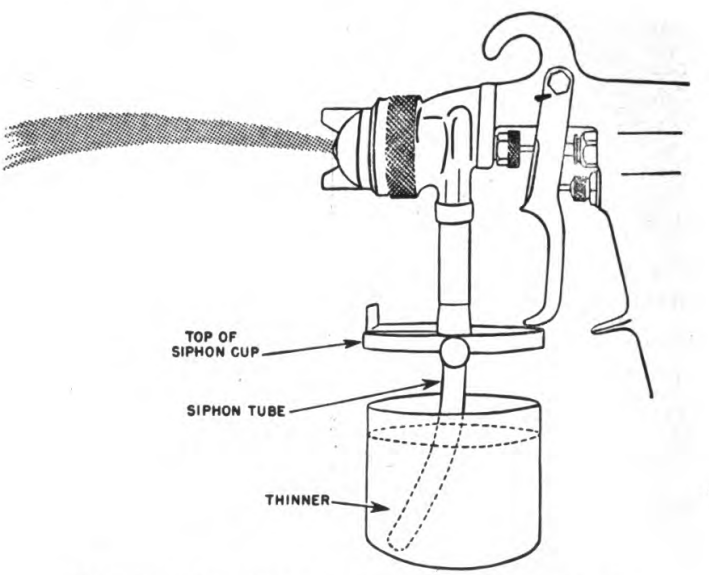

FIGURE 128.—Cleaning spray gun used with cup.

32. How to apply olive-drab lusterless synthetic enamel over old coat.—*a. Cleaning surface.*—(1) Use light duty cleaner for the under frame. Dissolve 1 or 2 ounces of cleaner in a gallon of water and spray it on hot with a steam gun. If a steam gun is not available, mix 1 quart of degreasing solvent with 5 quarts of kerosene and spray the mixture with an ordinary paint spray gun or brush it on. Let it stand for half an hour and flush it off with water.

(2) (*a*) On body paint, do not use either light duty cleaner or degreasing solvent; instead, sponge the surface with soap and water. Army issue soap is suitable. To avoid streaking, sponge the vehicle body with sidewise strokes, working upward from the bottom of the body. After the washing is done, rinse off all soapy water with plenty of clean, cold water, and allow the body to dry thoroughly.

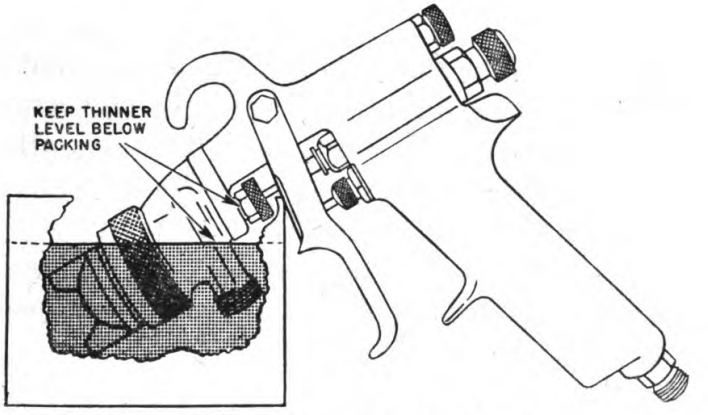

FIGURE 129.—Immersing nozzle and material connection.

(*b*) The next step is to remove the rust and loose paint clinging to the old paint job. Use a stiff wire brush for this. Then sandpaper the remaining loose, blistered, and cracked paint down to the bare metal—240-grit sandpaper is suitable. Apply metal conditioner (2 parts water to 1 part conditioner) to the bare metal spots; leave it on for 2 minutes and then flush it with water. This solution removes rust and produces a surface to which paint will cling tightly. Avoid getting the solution on the painted surface if possible. Wear rubber gloves to protect the hands; if the solution gets on the hands, apply baking soda and douse the hands with water.

(*c*) Sand the entire body with No. 240 sandpaper, used either wet or dry, and washed down with mineral spirits or a mixture of two parts of gasoline to one part of synthetic thinner.

(*d*) Now, using high-pressure air from the air hose (about 90 pounds per square inch), blow the dust off the entire vehicle.

(*e*) The vehicle is now ready to paint.

b. Masking.—Mask all windows and other parts not to be painted, preferably with Scotch tape.

c. Applying intermediate coating.—Spray the entire surface with one coat of intermediate coating, thinned with 1½ parts of thinner, using a pressure of about 55 pounds per square inch at the gun. This coat should be sprayed on full or wet so it will dry smooth. Allow 20 to 30 minutes for drying.

d. Applying finishing coat.—(1) For finishing coats, thin lusterless olive-drab enamel with one-fourth part of synthetic thinner. Ordinarily, a pressure of about 55 pounds per square inch at the gun should be used but on hot days this may be reduced 10 or 15 pounds. The pressure should be reduced before starting to paint however, so that the entire job gets the same pressure; otherwise, color changes will appear. Apply a medium coat first, holding the gun not more than 18 inches from the surface.

(2) In very hot weather the thinner may be too volatile (that is, it will evaporate before the paint hits the surface) and cause the paint to hit the surface in nearly dry particles. This is called "dusting." Adding of 2 ounces of clean kerosene to a gallon of thinner before it is used to dilute the enamel will relieve this condition.

(3) As soon as the first coat has flattened down, or lost its gloss, follow it with a second full, wet coat. Let this coat dry 4 hours or overnight before putting the vehicle in service.

33. Alternative method.—If time, labor, and facilities are available, a more durable job can be obtained by applying a thin coat of primer ground instead of intermediate coating, over the old paint. Thin the primer ground with one-fourth part of thinner. If this method is used, clean the old coat of paint very thoroughly before applying the finishing coats of olive-drab lusterless, and then allow about 16 hours for the priming coat to dry before the finishing coat is applied. This long drying time allows the priming coat to pick up considerable dust unless the vehicle is in a well-protected location.

34. Old paint in bad condition.—*a. Stripping.*—If old paint is in bad condition, the only way to do a good job of refinishing is to remove the old paint completely, down to the bare metal. Probably the easiest way of removing old paint is to use alkali paint stripper, 6 to 10 ounces to a gallon of water, applied hot.

(1) There are two ways to use the stripper. One is the "trickle" system of allowing the solution to drip on the vehicle from an overhead, perforated lead pipe until all the paint is off. If such equipment is not available, apply the hot solution heavily with an old brush. Do not spray it, because it will probably go where it is not wanted and may

ruin the gun. Wear rubber gloves to protect the hands from the caustic solution, which is very corrosive. If it gets on the skin, wash it off immediately with cold water and then apply vinegar to neutralize any remaining alkali. Let the stripper act on the paint for about 5 minutes, and then hose it off with cold water. Repeat the process on spots where the paint has not come off.

(2) After the paint is entirely removed, wash off every trace of the stripper with cold water, taking special care at moldings, door frames, and the like. Any stripper left on the surface will blister, whiten, or remove the new paint.

(3) Alkali stripper will swell wood and eat into it like acid. Keep them apart. Remove old paint from wood with paint remover or burn it off with a torch.

(4) If it is not convenient or desirable to use alkali stripper, apply paint remover or chlorinated solvents.

b. Metal conditioning.—Heat the entire metal surface with metal conditioner, and wash it. See paragraph 32*c* for the safe method of applying and removing the coating.

c. Priming.—(1) After washing, spray the bare metal surface with a coat of metal primer, which dries in 20 to 30 minutes. This material requires no thinning. The finishing coat of lusterless olive-drab enamel may then be applied as described in paragraph 32*d*.

(2) If time permits, a more durable job may be obtained by using rust-inhibiting primer, a material especially developed for use under the lusterless synthetic enamel. Thin it with one-seventh part synthetic thinner and apply it somewhat more heavily than ordinary primers. It requires about 16 hours drying time before the finishing coat may be applied. It need not be sanded.

(3) When bare wood is to be painted, the preferred procedure is to brush on one coat of clear sealer for wood, let it dry 4 hours or overnight, and then brush on a coat of refinishing primer and allow it to dry overnight before applying the finishing coat of lusterless.

35. Brush application of lusterless enamel.—Lusterless enamel can be brushed on if spray equipment is not available. Brushing will leave brush marks, however, and produce an inferior job The preferred procedure is as follows:

a. Clean and prepare the surface just as for spray application. Use primer ground over an old coat or rust-inhibiting primer as a first coat on bare metal. Apply either of these primers as it comes from the can, or thinned with not more than 5 percent of synthetic thinner. Brush it on as thinly as possible. The primer coat should dry for

about 16 hours. If it dries too quickly, slow up the drying rate of the thinner by adding 2 ounces of clean kerosene to a gallon of thinner.

b. For brushing, thin the lusterless olive-drab enamel as little as the primer. In applying the paint, flow it on and pass the brush through the paint as little as possible. One medium heavy coat is usually satisfactory.

36. Touch-up jobs.—*a.* The same fundamentals apply to touch-up jobs as to entire vehicles. Whenever possible, refinish an entire door, fender, or panel rather than "splicing," which will produce a noticeable difference in color. If you must splice, feather the edges of the old paint carefully with sandpaper around the spot to be refinished.

b. In emergencies, when it is necessary that the vehicle be "rolling" again in a short space of time, the rules of good practice must be violated. In these cases, only quick-drying primers or often only the finishing coat of olive-drab lusterless is used regardless of whether it is over bare metal or an old coat. *Such practices, however, will not result in satisfactory or lasting jobs. Avoid them when possible.*

37. Stenciling.—*a. Applying paper stencils.*—After the olive-drab lusterless enamel has dried about 4 hours, it will be dry enough to stand taping, and can be stenciled. Ready-cut paper stencils are best for lettering and numbering. Apply the special adhesive to the back of the stencil with a brush or touch-up gun. When dry, it will stick like Scotch tape. Then apply the stencils to the body and cut the ties out carefully with a knife or razor blade.

b. Painting stenciled characters.—Spray blue-drab enamel, as it comes from the can, with a touch-up gun (fig. 117). Using as little air pressure as will properly spread the paint, apply a solid, heavy coat. When it has dried for 10 minutes, pull off the stencils. The special adhesive used ordinarily leaves no marks.

c. Brass stencils.—Stencil sets ready-cut from sheet brass are sometimes used. These are applied with Scotch tape and used over and over.

d. Special designs.—If designs other than letters and numerals are required, or if ready-cut stencils are not available, stencils must be cut from stencil paper and applied with Scotch tape.

e. Removing smudges.—If gum smudges remain, wipe them off lightly with gasoline after the blue-drab enamel has dried for 2 hours. Be careful not to get any gasoline on the letters, numerals, or designs themselves.

38. Engines.—*a.* Before enameling an engine, clean it thoroughly with degreasing solvent or steam and hot water, and dry it completely.

b. Any grease left on it will make a dark spot on the enamel. For this reason, an engine is not usually repainted except when it is out of the vehicle and can be completely cleaned more easily.

c. Use no primer. Spray on one coat of synthetic gray heat-resisting motor enamel thinned with about 5 percent synthetic thinner and let it dry for 4 hours. Protect the spark plugs and wiring carefully from paint.

39. Tires.—Wash them and apply tire paint with a brush. They will dry in about 5 minutes.

40. Final inspection.—Remove the masking tape, clean the windows, and give the entire job a final inspection. If time permits, allow an additional 16 hours for drying before returning the vehicle to operation.

41. Safety precautions.—*a.* Respirators should be worn during all spray painting operations.

b. Adequate forced-draft ventilation for indoor work should always be provided to carry off the fumes.

c. Preparations for spraying containing benzol should always be rejected. Inhaling its fumes is extremely injurious to health.

d. Fires which occur in spray booths result from six principal causes: broken electric lamps and other electrical defects; cleaning interior of booths, fans, and motors with highly flammable solvents; accumulation of deposits in the booths, tubes, and vent pipes, resulting from neglect to clean them frequently; defective fans and motors used for ventilating the booths; poorly designed and guarded vent tubes; and static electricity.

e. Lusterless olive-drab enamel presents a greater fire hazard than ordinary enamels. Accumulated spray dust in booths and in cracks and corners of the paint shop is particularly dangerous, for it easily flares up in spontaneous combustion and has started many fires in this way. The only way to eliminate this hazard is to *keep the paint shop clean.* Scrape all spray dust off the walls and out of spray booths, corners, or any other place in which it accumulates. Special nonsparking bronze scrapers are desirable for the purpose. Before throwing the scrapings away, wet them down with water.

f. Never use inflammable solvents to clean the walls of spray booths.

g. The mist that comes from a spray gun is very inflammable. A spark will cause it to flash. Smoking is prohibited in the paint shop.

h. Only vapor-proof lamps should be used where spraying is being done.

i. Remove and destroy paint- or oil-soaked rags promptly; do not let them lie around the shop, where they may unexpectedly flare up and start a serious fire.

j. Main supply of solvents, paints, lacquers, and such flammable liquids should be stored outside the building in a separate enclosure.

SECTION V

GLASSWORKER

42. What glass is.—*a. General.*—(1) The ability of glass to transmit light and offer protection against air, water, and dust—qualities discovered 4,000 years ago by the ancient Egyptians—today make glass one of the most important automotive materials.

(2) Glass is an "undercooled liquid" because it does not melt at a definite temperature as a solid would. Like wax it becomes softer and more pliable as the temperature rises. At ordinary temperatures it is rigid, not easily corroded except by hydrofluoric acid, and comparatively resistant to abrasion. Salt water has a chemical or abrasive action on glass that causes a frosted appearance after sufficient exposure. It is only slightly porous and therefore easily cleaned. Glass is not entirely colorless. Although the color cannot be seen by looking through an ordinary sheet of glass, one may detect a green, blue, or yellow tint by looking through an edge.

(3) Glass is only slightly less strong than some grades of cast iron, but it is far more brittle, and any external force will set up stresses within it that will be retained for some time. Any force added to these retained stresses may cause a break. This property is a great aid in cutting sheet glass.

(4) Glass is made by combining a silicate such as common sand, an alkali such as sodium carbonate, and either lead or lime. It is commonly classified as lead glass or lime glass. Lead glass, which has the higher luster but is more brittle and more easily scratched, is used principally for optical and decorative purposes. Only lime glass is used for automotive work.

(5) Because the available supply of silicate, alkali, and lead or lime is not usually pure or readily usable, carbon, arsenic or other sub-

stances must be added to purify them and assist them in combining. Substances such as iron, copper, or chromium may also be added to change the color, hardness, or other properties. These solid components, melted together, form liquid glass. When its impurities rise to the surface, the molten glass is drawn off and allowed to harden.

b. Nomenclature.—(1) A sheet of glass is generally a large, flat piece having no particular shape. When the term is applied to laminated glass (par. 43) it means one of the layers. Laminated glass is sold in cut rectangular sheets from 4 by 18 to 24 by 56 inches, called blocks. About 50 square feet, weighing approximately 200 pounds, are ordinarily packed together and known as a box.

(2) Any piece of glass used to admit light is known as a light.

c. Plate glass.—(1) Plate glass is poured on a flat, heated surface, cooled until it becomes plastic, and then rolled to about twice the thickness intended for the finished plate. After rolling, it is slowly cooled or annealed, and when cold it is ground with sand and polished smooth and flat. Modern glass making is a continuous process in which glass comes out between rollers in a continuous ribbon. The ribbon is not cut until it is cold and ready for grinding.

(2) Grinding and polishing make the surface more porous and less resistant to attack by acids, alkalies, and (of special importance) salt water. It must be handled carefully and kept clean; crayon marks imbedded in its pores cannot be completely removed. Plate glass may be tempered to make it harder and more shock resistant.

d. Window glass.—Window glass is blown or poured into sheets of the desired thickness, then annealed, and cut to the desired size. Unlike plate glass, it is never ground or polished. The surface therefore is somewhat less porous than plate glass and more resistant to scratches and salt water, but it is slightly wavy. Like plate glass it may be tempered. Tests show that plate glass is markedly superior to window glass in motor vehicles for reducing fatigue and eye strain and increasing the ability to judge distance and to read road signs.

e. Tempered glass.—Tempered glass is made by reheating plate or window glass until it is somewhat soft, and cooling it quickly in a bath of hot oil or against a cold metallic surface. It will then withstand heavy impacts and great pressures. However, a comparatively light blow with a pointed object will break it on account of the internal stresses caused by the sudden cooling, and it may fly apart violently when broken. Because of these internal stresses, it cannot

be cut or ground, but is shaped when soft. Rear lights, particularly curved ones, may be of tempered glass, and the frames keep them from flying apart when broken.

f. Unbreakable glass.—Unbreakable glass is a form of tempered glass. It is misnamed, because although ordinary accidents will not break it, a sharp impact may shatter it.

g. Bulletproof glass.—Bulletproof glass has very limited uses. It is very thick, usually ¾ inch, and resists bullets. They may, however, chip or crack it. Bulletproof glass and curved lights, which are seldom used by the Army, are not ordinarily cut except in shops especially equipped for the purpose.

h. Safety glass.—Safety glass, which easily breaks into small rounded pieces like pebbles, is seldom used. Do not confuse it with laminated safety glass (par. 43), which is also generally called "safety glass." Because the laminated type is generally used, the term "safety glass" will always mean "laminated safety glass" unless otherwise qualified.

43. Laminated safety glass.—Glass that breaks into small, sharp pieces is dangerous to use for lights in motor vehicles. Manufacturers have therefore developed laminated safety glass, which is built up like a sandwich with a sheet of tough plastic material bonded between two sheets of glass. If this glass breaks, the plastic stretches when hit, serving as a cushion and holding the sharp glass fragments firmly. Except for its safety feature, laminated safety glass has the same properties as the glass from which it was made. It is used for replacement of practically all flat lights in Army motor vehicles, such as windows and windshields.

a. Plastic.—(1) The plastic in former types of laminated safety glass became milky or discolored when exposed to sunlight; it grew brittle in cold weather and soft in hot weather. Modern safety glass plastic is not so greatly affected in this way. High temperatures, however, and certain other conditions may decompose the plastic or separate it from the glass. When this occurs, the safety feature is lost, and the light should be replaced.

(2) Separation may occur at any place, not necessarily at an edge. It is generally recognized by a dull spot, or by distortion, very much as though the spot were wet. In certain lighting conditions, one may be able to see a rainbow, which shifts when the glass is pressed.

(3) Decomposed plastic is generally brown and difficult to see through. It may crack without cracking either of the outer sheets of glass. If the glass is heated at one spot, the plastic may decompose rapidly enough to explode the glass.

(4) Even though the glass is of even thickness, the plastic may cause the pieces to get slightly out of parallel, so that certain objects, particularly oncoming headlights, appear double.

b. Outer sheets.—(1) The outer sheets in laminated safety glass may be either window or plate glass, whichever is more suitable. Windshields are made of plate glass because it is highly important that they cause no distortion. Other lights are ordinarily made up of window glass, since the small amount of distortion is not objectionable.

(2) Both the window and plate glass sheets used for laminated glass are graded by thickness into single strength (SS), and double strength (DS). Any combination of thicknesses may be used, and the final piece listed as SS and SS, SS and DS, or DS and DS. Single strength sheets are about $\frac{1}{16}$ inch thick and double strength about $\frac{1}{8}$ inch thick. The plastic is about $\frac{1}{32}$ inch thick. The trade mark is always etched on the thicker sheet and is installed toward the outside, when the thicknesses of the two sheets differ.

(3) One sheet may crack without also cracking the other side, if it is chipped or subjected to uneven pressure of the retaining molding. Next to a direct blow, the most common cause of breakage is vibration of the glass in the frame, permitted by a loose fit, which usually cracks both sheets.

44. Removing motor vehicle glass.—Be careful not to break the pieces out when removing safety glass, not only to avoid being cut, but to preserve the old light as a pattern. Methods of removing glass vary widely, according to the construction of the door or window; therefore, always consult the manufacturer's maintenance manuals. Most Army windshield and door lights are enclosed in protecting metal channels, or frames, by which they are attached to the vehicle. Ordinarily, one should remove the framed light from the vehicle first, and then remove the frame, working at the bench.

a. Fixed lights.—Fixed lights are those that will not open, such as most rear windows and some windshields. To take them out, remove the moldings and loosen the rubber. Then force out the glass.

b. Hinged windshields.—If windshield hinges are concealed, disconnect the windshield operating mechanism and open the windshield fully; usually it can then be seen how it is attached. If they are full-length hinges, composed of a rolled strip attached to the body and a similar roll on the windshield channel, separate them while the windshield is open, by sliding the windshield sidewise.

c. Side windows.—Side windows slide in channels under control of a regulator arm hooked into the bottom of the glass channel. Re-

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move the inner garnish molding, and the channel also, if removable, to tip the glass inward. If the rim channels are not removable, roll the glass halfway up and press the top edge out of the channels. Channels on which this is done do not contain metal reinforcements, but are supported by garnish moldings. When the top edge of the glass is clear of the channels, roll the regulator up until the arm is exposed, and unhook the light.

d. Removing glass from channels.—(1) After removing the damaged light from the vehicle, inspect all channels, hardware, and weather stripping, and replace what is not reparable. If it is a

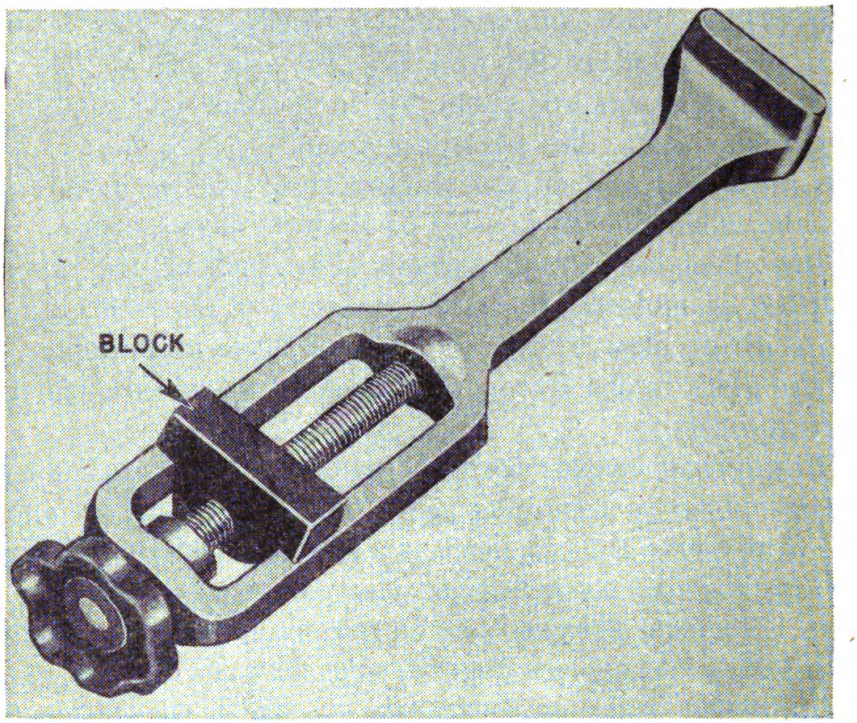

FIGURE 130.—Windshield tool.

fixed light, carefully check the opening to make sure that the metal flange or rubber molding is clean and free from dents, bumps, or twists which would strain and crack the glass.

(2) For removing and replacing the channels of completely framed lights, use the windshield tool, a spreader-and-clamp device (fig. 130). Turning the knob moves the block in or out, spreading or squeezing two opposite edges of a frame.

(3) The glass vise (fig. 131) has padded jaws to hold glass without scratching or cracking it. The notched upright column can be fitted to the vise and used as a fulcrum against which to pry off channels. Fit the lever into a notch at about the angle shown in the figure and grip the channel in the clamp. Press moderately on the

lever to start the channel off the glass, and then remove it by hand. The vise has an anvil for straightening channels and for removing glass broken off in the channel.

(4) If the frame has two channels, unfasten them and force one of the channels off with the windshield tool by exerting the spreading force at a corner. Remove the remaining channels with the glass vise.

(5) If the glass has been broken off close to, or in the channel, pull out as many pieces as possible with the pliers, and then drive the channel across the anvil to remove the remaining pieces.

(6) The channel must be free of all glass chips. If it is bent or dented, straighten it on the anvil before using it again.

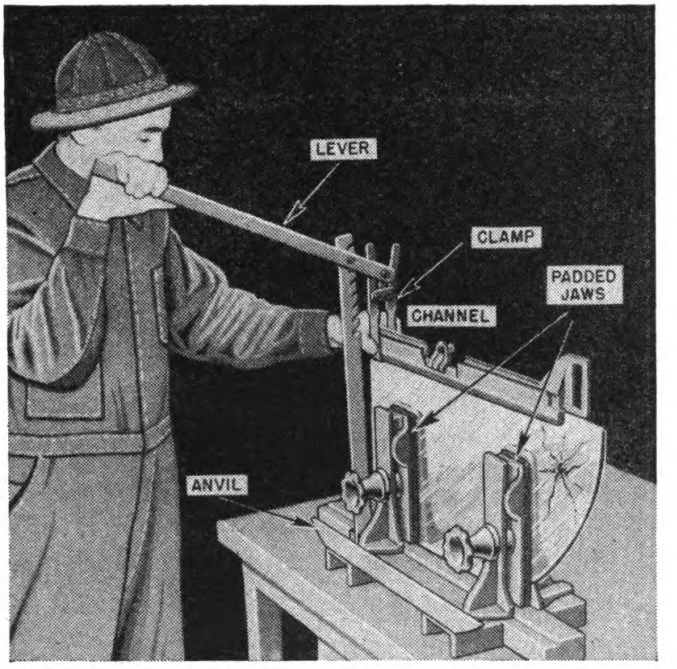

FIGURE 131.—Glass vise.

45. Cutting.—Cutting may be divided into three operations: making the cut, cracking the cut, and cutting the plastic. The first two are the most difficult, since they consist of setting up stresses in the glass to guide the crack, and applying forces which cause the glass to break along the lines of those stresses. Any other stresses may cause the crack to travel away from the desired line. Glass is a slow conductor of heat, but it expands when heated and contracts when cooled, even though the temperature change is slight. Therefore stresses are set up when the glass is heated, since the surface expands or contracts more quickly than the interior. Stresses can also be set up by supporting the glass on an uneven surface or applying any pressure to an edge or corner which is not supported.

a. Patterns.—Although straight-edged lights may be measured with a ruler, most others require patterns. The broken light makes an ideal pattern if the plastic center has held the fragments together. If not, one will have to use a paper pattern or remove a similar light from a vehicle. To make a personal file of paper patterns, copy every type of light replaced. Use clean, heavy, unfolded paper, tracing the exact outline of the glass sample with a sharp pencil. Mark the patterns with the vehicle model, style, and year, and store them flat, never folded or rolled.

b. Equipment used.—(1) *Cutting bench.*—The cutting bench may be of wood or steel, with a flat wooden top larger than the largest block that will be cut on it, and high enough for the operator's convenience. It is covered with a material such as oilcloth, which is soft enough to prevent scratching, yet hard enough to support the glass rigidly, and tends to keep the glass from sliding. It can readily be cleaned of dust and chips. The cutting table may be fitted with a tool drawer. Locate the table where temperature changes are the least to minimize internal stresses. Especially, keep it out of drafts. Using a second table with an uncovered wooden top for all work other than cutting and cracking will keep the cutting table clean and unscratched.

(2) *Bins.*—The Army obtains glass in the fewest standard sizes from which all usual lights can be cut economically. It is stored vertically in wooden bins, one bin for each size of glass. Each bin is clearly marked as to size, type (polished or window) and make-up (such as SS and DS). Bins should be located near the cutting table, where temperature changes are at a minimum. The following sizes of glass are stocked at present:

DS and DS ¼-inch polished	*SS and DS 3/16-inch window*	
18 by 48	14 by 24	18 by 26
18 by 50	14 by 26	18 by 28
16 by 26	16 by 26	20 by 28
		20 by 30

(3) *Ruler.*—A ruler, wider than a common yardstick and possibly thicker and longer, is often used for guiding the cutter. There is usually a small flange at one end that may be hooked over an edge when measuring, to eliminate the necessity of holding that end. The ruler is marked in eighths of an inch.

(4) *Glass cutter* (fig. 132).—The common glass cutter has a small, sharp, hardened-steel wheel mounted on a pin in a handle. Handles vary in length and size according to the operator's particular prefer-

ence, and wheels vary in diameter. Faces are notched for breaking plain window glass, but this feature is of no value with laminated safety glass. For safety glass, cutters with small wheels give best results. Diamond-tipped cutters are sometimes used, although the steel-wheel type is easier to use and better for general work.

c. Making cut.—(1) Just before making a cut, dip the cutter in kerosene, turpentine, or light oil, and lightly coat the place to be cut with the same lubricant. If a ruler is used, hold the face of the cutter against it so that the wheel rolls straight in the direction of the cut. If a pattern is used, place it under the glass and run the cutter smoothly with moderate, steady pressure, guiding it by hand. A dragging wheel will make a "snowy" cut which will not guide the crack. Practice until straight cuts can be made in one pass, from edge to edge of the block.

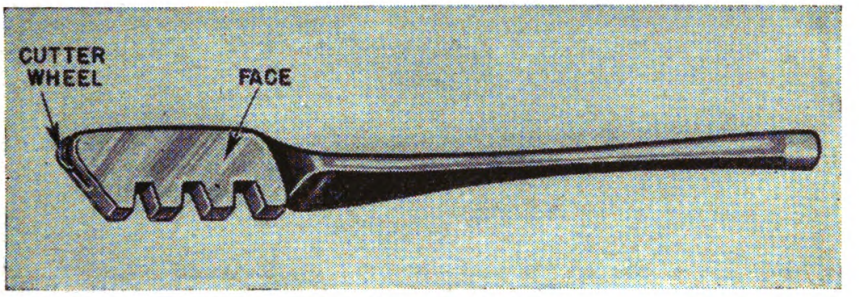

FIGURE 132.—Glass cutter.

(2) Always cut a light the exact size of the pattern, to be finished 1/32 inch smaller. Start and finish the cut at an edge of the block. It is preferable that cuts run as nearly straight as possible. If a curve is sharp, remove as much waste as possible with a straight cut, and finish the curve later on the edger. At a sharp corner, make two separate cuts. If the block is made up of two different thicknesses, the sheet bearing the trade-mark must be on the outside of the vehicle when the light is installed, since it is the stronger. Cut it accordingly.

(3) The two most common faults in cutting are skips and chipped cuts. Skips are caused by a dull, stuck, or flat wheel; by uneven pressure or too much pressure; and by unsteady support of the glass. Chipped cuts are caused by too much pressure, insufficient or no lubricant, or a poor wheel. If an excessively sharp new wheel flakes the glass, dull it slightly by drawing it heavily several times across a piece of scrap glass.

d. Cracking.—(1) Immediately after cuts have been made, they must be cracked. If one waits more than 1 or 2 minutes, the cut will "heal," or relieve itself of the internal stresses, and although its appearance will be unchanged, it will no longer guide the crack.

(2) Slide the glass to the edge of the table until the waste piece overhangs. Carefully press on a corner of the waste until the crack starts. Follow along, applying pressure behind the crack as it travels along the cut, until it reaches the other edge. The lubricant applied for cutting will run into the crack and make it readily visible. When a corner is reached, tap the waste with the cutter or pliers to run the cut. Do not apply more than enough pressure to make the crack travel along, or the crack will not follow the cut. Do not try to crack the whole cut at once by pressing in the middle. Cracking cannot be rushed.

(3) If the waste strip is less than 1 inch wide, glass pliers (fig. 133) will be needed to press the waste down away from the cut. Take particular care to run the crack completely if the waste is narrow.

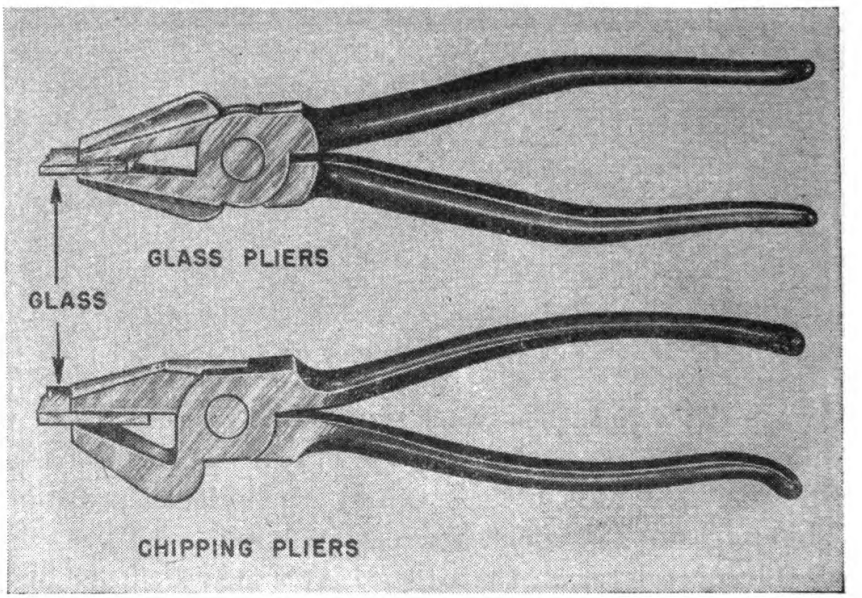

FIGURE 133.—Glass pliers.

(4) Glass pliers commonly used in Army work have wide, flat jaws which are parallel when opened about ½ inch. They grip the glass as shown in figure 133, firmly but without crushing it. They are made in a number of sizes and styles, some of which have the jaws at right angles to the handles. Do not confuse them with chipping pliers (fig. 133) which are not used in safety glass work. Chipping pliers are distinguished by jaws that are flat but not parallel, which by exerting a controlled crushing and bending force, can be used to chip away small pieces. In safety glass the center plastic makes chipping impossible.

(5) It is best to crack all cuts on one side of a safety glass block, then repeat the process on the reverse side exactly opposite those

cracks. The cuts may, however, be made on both sides and then cracked in one operation, bending the waste up and down to run the cracks together. Cuts must not cross each other. It is therefore often necessary to remove the waste from one edge before making the cut for the adjoining edge.

(6) The common difficulty in cracking cuts is failure of the crack to follow the cut. This may be caused by a poor cut, a cold draft on the glass, failure to make the cut on the reverse side directly opposite the first or failure to run the crack soon enough after cutting.

e. Cutting plastic.—(1) After both sides have been cut and cracked, the waste piece is held only by the plastic. This can be cut either with a razor blade or with a hot wire. To cut it with a razor blade, rest the glass on the edge of the bench, with the waste overhanging;

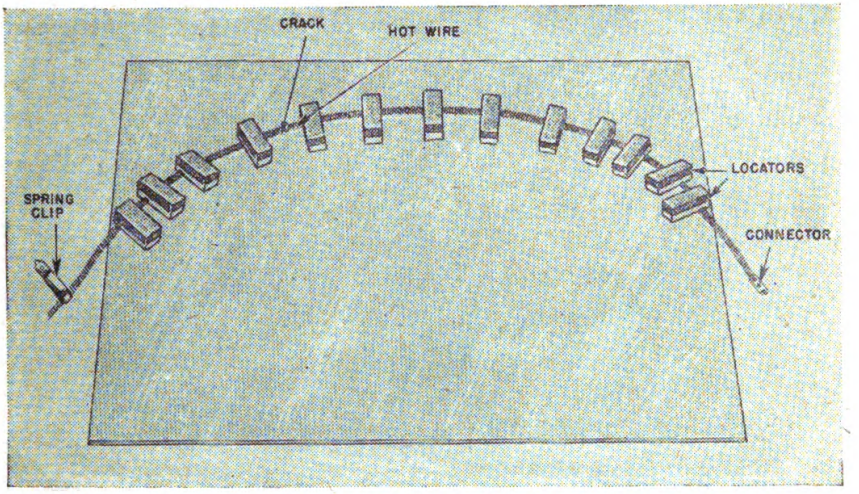

FIGURE 134.—Hot wire.

then insert the blade, bending the waste down slightly, and cut. Bending too far will chip the glass. This method may be used, ordinarily, at temperatures above 75° F.

(2) The hot wire (fig. 134) is a wire coil 60 or 72 inches long or even longer, and about ¼ inch in diameter, usually heated electrically. Weight it down on the waste piece, following along the crack, with the notched asbestos-and-lead locators on the good piece. One lead from the switch on a 110-volt circuit is permanently connected to one end of the wire, and the other lead is attached by a clip at such a point on the wire that the wire is heated to a cherry red. As the glass is heated, grip the waste piece with glass pliers, holding the good piece with the other hand or with clamps (fig. 135) and pull straight out with moderate force. Bend the waste as little as possible. The heated plastic softens and the waste drops of its own weight. Waste pieces less than an inch wide may have to be removed with pliers.

(3) Common difficulties in the hot wire operation are bubbling in the plastic, caused by too hot a wire or too long a heating time; separation of glass sheets along the edge of the cut, caused by stretching the plastic excessively; and chipping along the cut, caused by bending the waste strip up and down, rather than pulling it straight out.

46. Finishing.—Cut edges of glass are dangerously sharp and must be handled with particular care. If installed in this condition, they will damage the channels. They are therefore ground to a smooth finish on an edging machine (figs. 136 and 137). The wheel-type edger (fig. 136) is a combination edger with the different wheels necessary to make a complete finishing job, roughing, smoothing, and

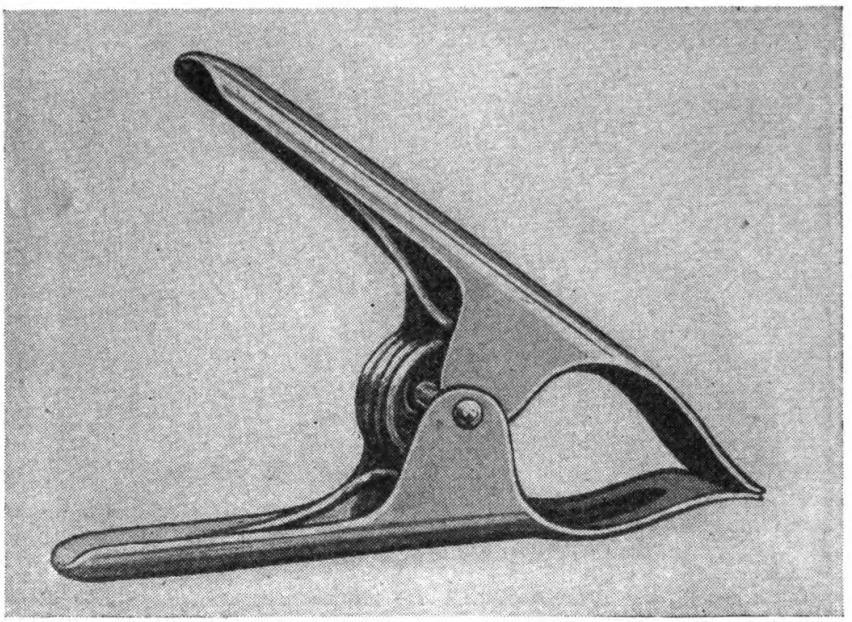

FIGURE 135.—Clamps.

polishing. The belt type (fig. 137) accommodates only one belt at a time. Each type is available in numerous combinations.

a. Roughing.—(1) The flat roughing wheel, which removes excess glass and raw edges, is generally made of a high grade cast iron and is driven by its own motor. The trough is partly filled with abrasive powder. Water drips on this abrasive from a spout, mixing with it and carrying a thin trickle onto the iron wheel. For safety glass, 120-grit silicon carbide or aluminum oxide is used. Other grits may be used for some special purposes.

(*a*) For roughing, hold the glass vertically and start to grind at a corner, passing the glass smoothly and evenly across the wheel. Lift the glass from the wheel and repeat the operation. Never move the glass back and forth, and do not tip or rock it, because it may chip.

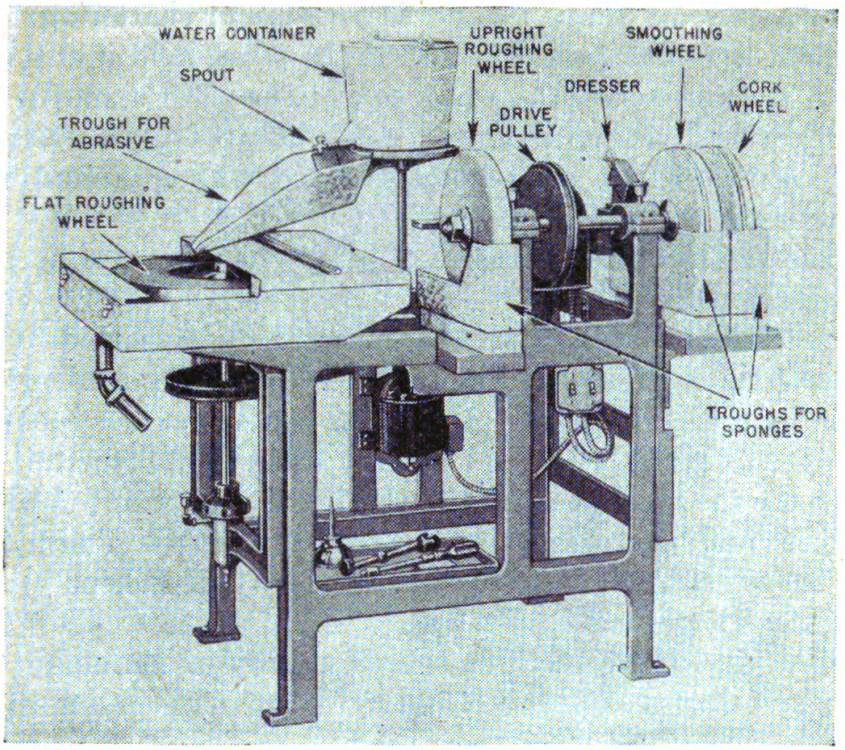

FIGURE 136.—Wheel edger.

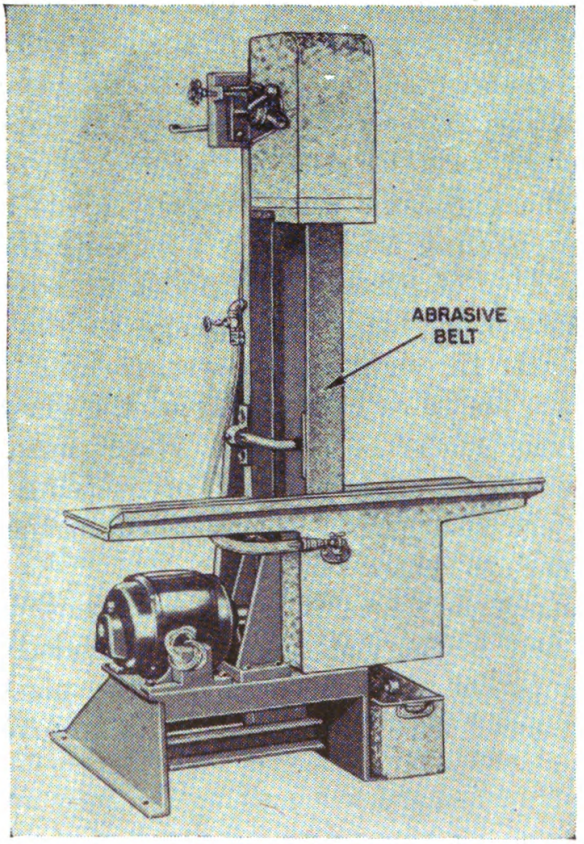

FIGURE 137.—Belt edger.

Chipping may also be caused by uneven pressure or chattering. When a smooth, flat edge has been obtained on the glass, hold it at an angle and pass it straight across the wheel so as to bevel or seam the edges. Round all corners. After roughing, wash off all loose abrasive (see par. 47). A wheel that has become grooved with use must be machined, reversed, or replaced.

(*b*) Some machines use abrasive wheels, which require no trough and abrasive powder.

(2) The upright roughing wheel is made of silicon carbide or other abrasive material. This wheel and the smoothing and polishing wheels are driven by the same motor. Use it for concave curves such as the bottom edges of windshields and for any other edges where it is not possible to use the flat wheel. This wheel is more difficult to use than the flat wheel, and requires greater care to keep the glass in firm contact with the wheel and to avoid rocking. The wheel is kept wet by a sponge in the trough under the wheel.

b. Smoothing.—The smoothing wheel, usually of aluminum oxide, has a finer grit than the upright roughing wheel and grinds a smoother edge. Most smoothing wheels are grooved so that they will round edges. As glass edges in Army motor vehicles are usually covered by fixed channels, this wheel will seldom be used. If there are any exposed edges, however, or edges that slide in channels, smooth them on this wheel in the same manner as on the upright roughing wheel. The smoothing wheel is also kept wet by a sponge. If the grooves do not round the edge enough, rock the glass in the grooves.

c. Polishing.—The polishing wheel, usually made of cork, is seldom needed, since polishing is ordinarily done only for exceptionally good appearance. If it is necessary to polish an edge, apply water and pumice to the wheel, using the sponge in the trough below. Pass the glass quickly through the grooves, rocking it if necessary. Take particular care not to catch a corner of the glass on the wheel.

d. Care of abrasive wheels.—Abrasive wheels must sometimes be dressed or reshaped by holding a cutter or dressing pencil against the wheel. They are also glazed or smoothed in the same fashion with a glazing pencil, to reduce chatter.

e. Sealing.—Sealing the edges of safety glass now being produced is not necessary, and is not generally recommended. If it should be ordered by competent authority, remove the plastic to a slight depth with a high speed wire brush and fill the groove with a safety glass sealer.

f. Drilling.—Drilling in glass is done with a drill press using special glass-cutting drills. Generally, however, the work is not done in Army shops.

47. Washing.—Because grinding compounds allowed to remain on the glass will scratch it, the glass must be washed. Therefore, the shop should have either a tank large enough to hold the largest light to be cut, or a spray that will wash the whole light at one time. A spray is made from a pipe about 50 inches long, in which holes are drilled at 1-inch intervals. One end is capped, and the other is connected to a foot-operated water valve and a drain is provided.

48. Installing.—*a. Taping.*—Always retape the glass with new tape when replacing channels.

(1) "Everseal" tape contains rubber and swells after being installed. This property makes it easier to use and insures against leaks and looseness. It is used in four sizes: $\frac{1}{32}$ inch thick by $1\frac{1}{4}$ inches wide, $\frac{1}{32}$ by $1\frac{1}{2}$, $\frac{3}{64}$ by $1\frac{1}{4}$, and $\frac{3}{64}$ by $1\frac{1}{2}$. The rolls contain 125 feet of tape $\frac{1}{32}$ inch thick or 100 feet of tape $\frac{3}{64}$ inch thick.

(2) Sponge rubber or cork tape does not swell after installation, and therefore must be applied more carefully to insure the proper tightness. It is ordinarily available only in $\frac{1}{32}$- and $\frac{1}{16}$-inch thicknesses. (The tape sizes just listed are the most economical to use, but other sizes are available.)

(3) When installing the first channel, clamp the new light in the vise. Lay the tape along the edge of the glass for the length of the channel. The tape must be thick enough to make a tight fit and wide enough to project above the channel when the glass is seated in the channel. To lay the tape around a corner, pinch the excess together in pleats with the pliers and cut it off smooth. Never leave a double thickness.

b. Seating glass in channel.—(1) Put the glass in the channel so that the trade-mark surface, indicating the heavier sheet, will be out. Seat it in the channel by striking moderate blows of a rubber hammer or by tapping against the channel driver (fig. 138). The channel driver distributes the force of the blow over a comparatively large area of the channel, and avoids bending or distorting it. It is offset so that it can be used under the regulator channel as shown in the figure.

(2) Drive the channel straight down from the center rather than starting at a corner, so that it will be centered. Always force the channel onto the glass rather than the glass into the channel. These precautions will help to avoid wrinkling the tape or breaking the

glass. The channel must be tight enough to prevent rattles but not so tight as to risk breakage.

(3) When using "everseal" tape, coat lightly with oil the side of the tape on which the channel is to slide. Then seat the channel firmly by hand pressure alone. The oil swells the tape, making a tight fit.

(4) Start the opposite channel in the same way. If more than hand pressure is necessary to seat it properly, use the windshield tool.

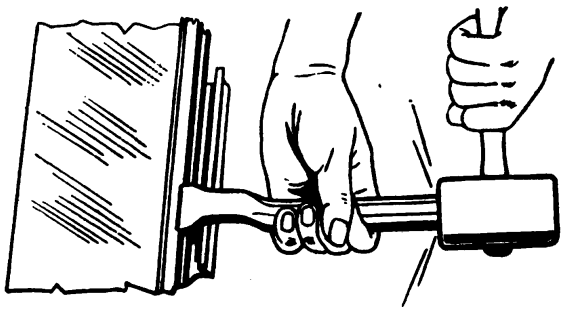

FIGURE 138.—Channel driver.

(5) When all channels are properly fastened, trim off the excess tape with a razor blade.

c. Installing lights.—This is usually done simply by reversing the removal process (par. 44) after making sure that the trade-mark on the thicker sheet of glass is on the outside. Fixed lights set in rubber are difficult to replace if the rubber is stretched or swelled. If it is necessary to remove a small piece of the rubber, make the cut so that any leakage after the window is installed will be drained away (usually at the bottom). If the rubber wrinkles behind the glass, the glass will crack. Always consult the manufacturer's maintenance manual when installing a fixed light, because some may have to be sealed in the opening.

APPENDIX

BIBLIOGRAPHY

The following sources have been consulted for illustrations and text material in the preparation of this manual. They contain more detailed information than is given herein and are suggested as collateral reading.

Frank D. Graham and Thomas J. Emery, *Audels Carpenters and Builders Guide No. 1* (New York, New York: Theo. Audel and Company, 1939).

U. S. Department of Agriculture, Forest Service, Forest Products Laboratory, *Wood Handbook* (Washington, D. C.: Government Printing Office, 1935).

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(For explanation of symbols see FM 21–6.)

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